
Section 7 Biological Assessment

ACOE Project Reference: SPK-2011 00039
Antioch Wharf Breasting Dolphin Replacement
Georgia-Pacific Gypsum, LLC.
Antioch, Contra Costa County, California

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January, 2015

Revised Dates:

June, 2015

and

May, 2015



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LIST OF ACCRONYMS AND ABBREVIATIONS

ACOE	US Army Corps of Engineers
Applicant	Georgia-Pacific Gypsum LLC
CDFW	California Department of Fish and Wildlife
CLSC	California State Lands Commission
dB	decibel
DPS	Distinct Population Segment
ESA	Endangered Species Act
ESU	Evolutionary Distinct Unit
Ft	feet or foot
GP	Georgia-Pacific
LMB	Lange's metalmark butterfly
MHHW	mean higher high water
µP	micro Pascal
m	meters
MOTEMS	Marine Oil Terminal Engineering and Maintenance Standards
NLAA	Not Likely to Adversely Affect
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Association
RMS	root mean square
RWQCB	Regional Water Quality Control Board
SEL	sound exposure level
Wharf	Georgia-Pacific Antioch Wharf
USFWS	US Fish and Wildlife Service

DEFINITION OF TERMS SPECIFIC TO PROPOSED PROJECT

Action - Required activities undertaken for mooring and berthing replacement and wharf repair, including avoidance and minimization proposed for unavoidable impacts.

Action Area - The regions where the Action will take place and additional areas that may be affected by the Action. The Action Area includes the Georgia-Pacific Antioch Wharf and adjacent staging, access, and work areas. The Action Area also includes areas outside the Project Area (see Section 3.0) to demonstrate potential acoustic effects of the Action.

Project Area – The areas where wharf replacement and improvements will take place. The Project Area includes the existing Georgia-Pacific Antioch Wharf structure and breasting dolphins to be demolished or removed, and the replacement wharf walkway structures, mooring dolphins, and breasting dolphins, along with adjacent staging, access, and work areas.

1.0 INTRODUCTION

The purpose of this Biological Assessment is to describe the proposed construction activities associated with required upgrades at the Georgia-Pacific Antioch Wharf (Action) located in Antioch, Contra Costa County, California (Wharf, Figure 1) in sufficient detail to determine to what extent the proposed Action may affect any of the threatened, endangered, or candidate species listed in Appendix A that are likely to be present in the Action Area, and any designated or proposed critical habitat in the Action Area. This Biological Assessment was originally submitted to U.S. Army Corps of Engineers (ACOE) on January 16, 2015, **was revised May 6, 2015 to address additional species concerns for U.S. Fish and Wildlife Service (USFWS), and has since been revised a third time as required by ACOE.**

On behalf of the Applicant, Georgia-Pacific Gypsum LLC (GP or Applicant), WRA, Inc. (WRA) submits this Biological Assessment to the Sacramento Corps Regulatory Division to accompany the Request for a Minor Impact Letter of Permission Permit for the Antioch Wharf Breasting Dolphins Replacement Project (Project) Reference # SPK-2011-00039. Project activities entail repair of an existing wharf to meet state engineering requirements of the California State Lands Commission (CSLC) Marine Facilities Division and to continue to safely accommodate larger vessels under current shipping contracts (see Figure 2). Based upon the analysis included herein, avoidance and minimization measures are recommended to avoid and limit take or other impacts to the listed species and critical habitat that may be affected by the proposed Action. Of the many species with potential to occur in the general region, only six aquatic species have the potential to occur in the Action Area: Delta smelt (*Hypomesus transpacificus*; Federally Threatened), Central Valley steelhead (*Oncorhynchus mykiss*; Federally Threatened), Southern Distinct Population Segment of green sturgeon (*Acipenser medirostris*; Federally Threatened), Central Valley spring-run Chinook salmon (*O. tshawytscha*; Federally Threatened), Sacramento River winter-run Chinook salmon (*O. tshawytscha*; Federally Endangered), and longfin smelt (*Spirinchus thaleichthys*; Federal Candidate). In addition to the six aquatic species, one terrestrial species, Lange's metalmark butterfly (LMB; *Apodemia mormo langei*) occurs within the Action Area. The Action Area also includes critical habitat for green sturgeon, Central Valley steelhead, and Delta smelt. This Biological Assessment is prepared in accordance with legal requirements set forth under Section 7 of the Endangered Species Act (ESA) (16 U.S.C. 1536 (c)).

1.1 Federally Listed Species Considered (Including Candidate Species)

Species considered in this document are listed in Table 1. Due to the lack of suitable habitat within the Project Area, it was determined that the proposed Action would have no effect on Callippe silverspot butterfly, Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, valley elderberry longhorn beetle, vernal pool tadpole shrimp, tidewater goby, California tiger salamander, California red-legged frog, Alameda whipsnake, giant garter snake, Western snowy plover, California clapper rail, California least tern, salt marsh harvest mouse, San Joaquin kit fox, large-flowered fiddleneck, pallid manzanita, Contra Costa wallflower, Santa Cruz tarplant, Contra Costa goldfields or Antioch Dunes evening primrose. These species are not considered in this analysis because the Action is taking place in a freshwater to brackish deepwater subtidal area in the San Joaquin River where no vegetation is present. Furthermore, adjacent vegetated habitats are not documented to support these species.

Table 1. Federal listed and candidate species, and critical habitat considered in this document.

Common name (Scientific name) Federal Status	Effect Determination
Lange's Metalmark Butterfly (<i>Apodemia mormo langei</i>) E	May Affect But Not Likely to Adversely Affect
Conservancy Fairy Shrimp (<i>Branchinecta conservation</i>) E	No Effect
Longhorn Fairy Shrimp (<i>Branchinecta longiantenna</i>) E	No Effect
Vernal Pool Fairy Shrimp (<i>Branchinecta lynchi</i>) T	No Effect
Valley Elderberry Beetle (<i>Desmocerus californicus dimorphus</i>) T	No Effect
Vernal Pool Tadpole Shrimp (<i>Lepidurus packardii</i>) E	No Effect
Callippe Silverspot Butterfly (<i>Speyeria callippe callippe</i>) E	No Effect
Bay Checkerspot Butterfly (<i>Euphydryas editha bayensis</i>) T	No Effect
Green Sturgeon (<i>Acipenser medirostris</i>) T	Likely to Adversely Affect
Tidewater Goby (<i>Eucyclogobius newberryi</i>) E	No Effect
Delta Smelt (<i>Hypomesus transpacificus</i>) T	Likely to Adversely Affect
Central California Coast Coho Salmon (<i>Oncorhynchus kisutch</i>) E	No Effect
Central California Coastal Steelhead (<i>Oncorhynchus mykiss</i>) T	No Effect
California Central Valley Steelhead (<i>Oncorhynchus mykiss</i>) T	Likely to Adversely Affect
Northern California Steelhead (<i>Oncorhynchus mykiss</i>) T	No Effect
Central Valley Spring-run Chinook Salmon (<i>Oncorhynchus tshawytscha</i>) E	Likely to Adversely Affect
Winter-run Chinook Salmon, Sacramento River (<i>Oncorhynchus tshawytscha</i>) E	Likely to Adversely Affect
Longfin Smelt (<i>Spirinchus thaleichthys</i>) FC	Likely to Adversely Affect
California Tiger Salamander (<i>Ambystoma californiense</i>) T	No Effect
California Red-legged Frog (<i>Rana aurora draytonii</i>) T	No Effect
Alameda Whipsnake (<i>Masticophis lateralis euryxanthus</i>) T	No Effect
Giant Garter Snake (<i>Thamnophis gigas</i>) T	No Effect
Western Snowy Plover (<i>Charadrius alexandrinus nivosus</i>) T	No Effect
California Clapper Rail (<i>Rallus longirostris obsoletus</i>) E	No Effect
California Least Tern (<i>Sternula antillarum</i> (=Sterna, =albifrons) browni) E	No Effect
Salt Marsh Harvest Mouse (<i>Reithrodontomys raviventris</i>) E	No Effect
San Joaquin Kit Fox (<i>Vulpes macrotis mutica</i>) E	No Effect
Large-flowered fiddleneck (<i>Amsinckia grandiflora</i>) E	No Effect
Pallid manzanita (<i>Arctostaphylos pallida</i>) T	No Effect
Soft bird's-beak (<i>Cordylanthus mollis</i> ssp. <i>mollis</i>) E	No Effect
Contra Costa wallflower (<i>Erysimum capitatum</i> ssp. <i>angustatum</i>) E	No Effect
Santa Cruz tarplant (<i>Holocarpha macradenia</i>) T	No Effect
Contra Costa goldfields (<i>Lasthenia conjugens</i>) E	No Effect
Antioch dunes evening primrose (<i>Oenothera deltoides</i> ssp. <i>howellii</i>) E	No Effect
Critical Habitat and Essential Fish Habitat	Effect Determination
Green Sturgeon	Not Likely to Destroy or Adversely Modify
Central California Coast Steelhead	No Effect
Central Valley Steelhead	Not Likely to Destroy or Adversely Modify
Winter-run Chinook Salmon	No Effect
Spring-run Chinook Salmon	No Effect
Delta Smelt	Not Likely to Destroy or Adversely Modify

The analysis included herein concludes that the Action may adversely affect green sturgeon, Delta smelt, Central Valley steelhead, spring-run Chinook salmon, winter-run Chinook salmon

(Sacramento River) and longfin smelt. **For Lange's metalmark butterfly, the analysis concludes that the Action may affect, but is not likely to adversely affect the species.** For designated critical habitat of green sturgeon, Central Valley steelhead, and Delta smelt, the Action is not likely to destroy or adversely modify the habitat. The avoidance and minimization measures proposed by the Applicant, along with the beneficial aspects of the Action, will offset effects of the Action and avoid unnecessary take of these species.

1.2 Critical Habitat

Critical habitat is a term defined and used by the Endangered Species Act (ESA) as a specific geographic area that contains features essential for the conservation of a threatened or endangered species and that may require special management and protection. The ESA requires federal agencies to consult with the USFWS and National Marine Fisheries Service (NMFS) to conserve listed species on their lands and to ensure that any activities or projects they fund, authorize, or carry out will not jeopardize the survival of a threatened or endangered species.

Critical habitat is currently designated for green sturgeon, Delta smelt and Central Valley steelhead within the Project Area (Figure 3).

1.3 Consultation to Date

- In 2007, the CSLC Marine Facilities Division notified GP that a condition survey and berthing analysis of the existing wharf was required. In response, a preliminary survey of the terminal and analysis of the existing structures was completed and conceptual design plans were developed to replace the berthing system at the Antioch terminal. A new lease was signed between GP and CSLC in November of 2011. Per the lease, the proposed draft plans for the wharf rehabilitation were submitted on November 21, 2012. In a notice dated February 5, 2013 the CSLC notified GP of their acceptance of the proposed Rehabilitation Plan. Since that time, a feasibility study and preliminary design has been completed. GP will now request regulatory agency authorization, including a Letter of Permission from the Sacramento District ACOE, to structurally upgrade the mooring and berthing system at the existing wharf to meet engineering requirements of the CSLC and to accommodate larger vessels calling at the wharf under current shipping contracts.
- October 23, 2014 a site visit to the Project Area was conducted with Ramon Aberasturi and Mike Finan, ACOE, Bruce Oppenheim, NMFS, and Armin Halston, USFWS. **The Action was discussed, and species and critical habitat that could be affected were discussed. This included fish species and critical habitat, but Lange's metalmark butterfly was not identified as a potential concern by ACOE or USFWS at that time.**

Between January 9 and June 12, 2015, more than 65 email and phone call correspondences occurred between ACOE and WRA. The following section provides a summary of correspondence during that period.

- January 16, 2015 an electronic version of the Biological Assessment was submitted to Ramon Aberasturi, ACOE, with hard copies submitted to ACOE on January 19, 2015.

- January 28, 2015, ACOE requested information on acreage of specific areas within the aquatic Action Area. Requested information was sent to ACOE on January 28, 2015.
- February 4, 2015, ACOE requested additional figures and areas for the aquatic Action Area without pile driving sound attenuation. Requested information was sent to ACOE on February 9, 2015.
- February 9, 2015, ACOE requested information on terrestrial acoustic sound at the closest housing and to what degree the Action may affect those locations. Requested information was sent to ACOE on February 10, 2015.
- March 23, 2015, ACOE requested information on terrestrial acoustic effects of the Action on Lange's metalmark butterfly and requested WRA create a terrestrial Action Area. Lange's metalmark butterfly previously was identified as unlikely to occur or be affected by the Action. On March 25, 2015, the Authorized Agent requested a call with USFWS and ACOE to identify how acoustic effects should be analyzed for the species. March 31, 2015, ACOE informed the Authorized Agent USFWS had not responded and provided some preliminary information on the Lange's metalmark butterfly, anthropogenic sound effects on invertebrates, and a potential minimization measure.
- April 22, 2015, ACOE reported to WRA that USFWS provided ACOE with preliminary information on minimization measures but did not have information on potential sound effects to Lange's metalmark butterfly.
- April 23, 2015, the Authorized Agent provided supplemental information addressing potential effects of the Action on Lange's metalmark butterfly and minimization measures to ACOE. This information was determined to be insufficient by ACOE, and additional potential Action effects on the species non-adult life stage, the catch and release propagation program, and additional minimization measures were requested.
- April 29, 2015, the Authorized Agent provided additional supplemental information addressing potential Action effects to Lange's metalmark butterfly life stages and the use of sound attenuation for terrestrial acoustic noise. ACOE informed the Authorized Agent that USFWS requested a federal agency meeting to discuss the Action and the direct, indirect and cumulative effects to the species and the ongoing catch and release program. ACOE also requested additional information regarding the clarity of the project description with regards to an increase in larger vessel traffic at the dock and the resulting potential for cumulative effects on Lange's metalmark butterfly from future larger vessel traffic.
- **May 1, 2015, ACOE requested additional information on ship traffic at wharf, and on May 5, 2015 requested information if dredging would occur. Information on ship traffic added to the Biological Assessment and no dredging by GP was planned for the Project.**
- **May 6, 2015, the revised Biological Assessment was sent to ACOE to incorporate all of the supplemental information requested and submitted to the ACOE between January 16, 2015 and May 5, 2015, as summarized above.**

- May 7, 2015, ACOE corresponded that the location and work window for the proposed Action were incorrectly identified based on the 2007 NMFS NLAA. WRA informed ACOE that the Project was not looking for coverage under the 2007 NLAA and once again requested that formal consultation be initiated.
- May 15, 2015, ACOE corresponded that formal consultation with USFWS and NMFS had not been initiated, and that the Biological Assessment still remained incomplete. No information was provided on why the Biological Assessment was considered incomplete, but ACOE was still concerned with potential Project effects to Lange's metalmark butterfly.
- May 18, 2015, ACOE corresponded that additional information was required for the Biological Assessment by USFWS. May 20, 2015, ACOE provided written comments from USFWS for what additional information to the Biological Assessment was required. ACOE informed WRA that it had forwarded on the Biological Assessment to NMFS for a "quick review". The full email of USFWS correspondence provided by ACOE is provided here:

"The Service has completed a brief review of the May 2015 Revised Biological Assessment, which you emailed me on May 7, 2015.

As for the proposed project description, it should include more detail concerning pile removal (e.g., what happens if they break and will water jetting be used). The proposed project description should also include a description of how ships utilize the dock, since the purpose of the subject proposed project is to safely accommodate the larger vessels currently accessing the wharf compared to past smaller vessels which the wharf was originally designed.

CNNDB Occurrences, Figure 3, should be revised to include Lange's metalmark butterfly

As for the effects to delta smelt, the BA does a good job of analyzing effects of increased hydroacoustics. The paragraph on turbidity needs to be further developed to include the expected raise and range of increased turbidity (NTUs), and duration of that raise above baseline. The paragraph also states that toxicity levels are not of concern, please provide the benchmark levels that were used and were they for humans or fish? The BA should also include an analysis of indirect effects (which can happen later in time) from gypsum offloading on the Lange's metalmark butterfly.

Due to the Service current priorities (drought and BDCP) and beside[s] a potential meeting with refuge staff, this is limit of technical assistance I can provide the subject proposed project until initiation of consultation."

- May 22, 2015, ACOE corresponded with concerns of ambient sound levels, that the tabletop levee identified in the Biological Assessment was part of the ADNWR preserve, and that additional discussion on sound propagation was required.

ACOE also requested that the Action avoid the estimated 7-week flight period for Lange's metalmark butterfly. ACOE and the GP Project team then had a conference call to discuss what information was required to finalize the Biological Assessment. ACOE corresponded following the call that the FWS federal agency meeting has scheduled for May 28, 2015 and brought up additional acoustic concerns to Lange's metalmark butterfly.

- May 27, 2015, for the ACOE and USFWS agency meeting, WRA provided a short Project summary and proposed minimization measures, responses to the USFWS Project description questions (received May 20, 2015), and outlined a list of questions for USFWS to help finalize the Biological Assessment.
- May 29, 2015, ACOE provided notes and a summary of the federal agency meeting with USFWS. ACOE requested additional information be provided for non-industrial human presence at ADNWR and that the Project completely avoid the Lange's metalmark butterfly flight season. ACOE corresponded that the Delta smelt section of the Biological assessment should be bolstered, and that there was not enough information available to support a mitigated decision for Lange's metalmark butterfly.
- June 2, 2015, ACOE and the GP Project team conducted a conference call to request to have WRA directly talk with USFWS to clarify what additional information and measures were requested from USFWS to complete the Biological Assessment. ACOE correspondence following the call included USFWS Lange's metal mark butterfly survey reports for 2013 and 2014, and requested additional revisions to the Biological Assessment to include buckwheat locations and information on human presence in ADNWR.
- June 4, 2015, WRA corresponded with ACOE outlining the list of revisions identified during the conference call that were required to finalize the Biological Assessment. ACOE responded with additional requested revisions to the Biological Assessment regarding human presence in ADNWR, the year work will be completed, additional documents from USFWS on recent beneficial sand placement at ADNWR, and a USFWS threats assessment document for Lange's metalmark butterfly (this was cited in the revised Biological Assessment previously and provided by ACOE May 6, 2015). ACOE also corresponded that NMFS had reviewed the Biological Assessment and did not have any changes or additions. ACOE informed WRA that formal consultation with both USFWS and NMFS would be required and that it was anticipated to take the full 135 day comment period, from the point formal consultation was initiated
- June 9, 2015, ACOE corresponded with concern over additional potential cumulative effects to Lange's metalmark butterfly, and details of volunteer events at ADNWR.
- June 12, 2015, ACOE corresponded with a description of information required to complete the Biological Assessment, which included the USFWS email language provided on May 20, 2015. Additional information requested included providing "relevant LMB [Lange's metalmark butterfly] maps and reports" provided by ACOE June 2-4, 2015, to revise the Project schedule, and that "pile driving activity

may adversely affect the human environment". ACOE also identified that "the Project may adversely affect LMB larvae during pile driving". Additional correspondence from ACOE on June 12, 2015, identifies that the Biological Assessment does not adequately describe documented Lange's metalmark butterfly presence, and it "appears there may be potential for minor variations in air pressure (sound) to affect LMB larvae". ACOE identified there may be "cumulative effects to LMB larvae due to existing gypsum dust of the buckwheat leaf and anticipated minor variations in air pressure (sound) due to the proposed project". ACOE provided additional correspondence on outstanding issues with the Letter of Permission application.

The third revision to the Biological Assessment includes responses for additional requested information from USFWS and ACOE as described above following the submittal of the May 6, 2015 revised Biological Assessment to ACOE.

1.4 Summary of Proposed Action

The proposed Action consists of structural upgrades at the Wharf, including adding, replacing, and removing pilings and decking in order to comply with state engineering requirements of the CSLC and to safely continue accommodating larger vessels currently under shipping contracts. Potential impacts to federal listed species occurring during construction will be minimized by Action design and implementation.

1.4.1 Action Agency

The Action Agency for the proposed Action is the U.S. Army Corps of Engineers.

1.4.2 Applicant, Contacts, and Authorized Agent

The Georgia-Pacific Gypsum LLC is the Applicant and will be responsible for minimization and avoidance measures related to the Antioch Wharf Rehabilitation project. The address and telephone number is:

Georgia-Pacific Gypsum LLC
801 Minaker Drive
Antioch, CA 94956
Contact: Fred Curcio, Antioch Plant Manager
(925) 732-4526

This biological assessment was prepared by WRA, Inc. and serves as the Authorized Agent. Contact information for the Authorized Agent is:

WRA, Inc.
2169-G East Francisco Blvd.
San Rafael, California 94901
Contact: Daniel Chase
(415) 454-8868

Additional information provided for the preparation of this document includes the hydroacoustic assessment prepared by Illingworth & Rodkin, Inc., and engineering design by the Ben C. Gerwick, Inc.. The addresses and telephone numbers are:

Illingworth & Rodkin, Inc.
423 4th Street, Suite S3W
Marysville, California 95901
Contact: Keith Pommerenck
(707) 794-0400

Ben C. Gerwick, Inc. | COWI.
1300 Clay Street, 7th Floor
Oakland, California 94612
Contact: Jack Gerwick
(510) 267-7172

1.4.3 Authority

GP is undertaking the proposed Action as a requirement of CSLC.

1.4.4 Purpose of Action

The intent of the Action is to structurally upgrade the mooring and berthing system at the existing Wharf to meet current standards as required by the CSLC. A condition survey and berthing analysis of the Wharf determined that structural repairs are required to safely continue accommodating larger vessels and was a condition of the renewed lease with CSLC. The structural upgrades are seismically designed in accordance with Chapter 16 of the 2013 California Building Code as well as Chapter 31F of the 2013 California Building Code, in the CLSC Marine Oil Terminal Engineering and Maintenance Standards (MOTEMS).

The above description of the purpose of the Action corrects a clerical error noted in Box 19. Project Purpose, in the Eng Form 4343 signed July 14, 2014, that misidentifies a component of the Project is to “accommodate larger vessels that *will* deliver gypsum to the plant under current shipping contracts”. The use of larger vessels is in place of previously smaller sized vessels and that no increase in the number of vessels, or gypsum volume will occur. Additional information on current operations with regards to larger vessel traffic is provided in Section 2.5.

2.0 EXISTING CONDITIONS

2.1 Action Area Location and Site Description

The Action Area is located in Antioch in northern Contra Costa County, California, just west of Highway 160 and north of Highway 4, on the shore of the San Joaquin River and about two miles west (down river) from the Antioch Bridge (Figure 1). The Project Area is currently a timber wharf that services a gypsum plant for Georgia-Pacific Gypsum LLC (Figure 2). The timber wharf is used for berthing of ships and offloading of gypsum.

2.2 Plant Communities

The Project Area is located in open water and does not contain plant communities. Based on the results of a subsurface exploration performed by Treadwell and Rollo, the site is underlain by river deposits to the maximum depth explored (elevation minus 134 ft Mean Lower Low Water). The river deposits generally consist of stiff to hard clays with varying amounts of sand and medium dense to very dense sand with varying amounts of silt and clay. The top layer sediment consists of stiff to very stiff clay and sandy clay. No rooted submerged aquatic vegetation is present within the Project Area.

The shoreline bordering the southern portion of the Project Area is a steep river bank armored with loose rock and is mostly unvegetated. Small areas of marsh vegetation occur along the waters edge, with more developed vegetation occurring west of the Project Area. Plant species detected along the shoreline include giant reed (*Arundo donax*), bulrush (*Bolboschoenus* spp.), soft rush (*Juncus effuses*), large leather-root (*Hoita macrostachya*), Himalayan blackberry (*Rubus armeniacus*), Hottentot fig (*Carpobrotus edulis*), and arroyo willow (*Salix lasiolepis*). Additionally, a few scattered coast live oak (*Quercus agrifolia*) and Oregon ash (*Fraxinus latifolia*) are found along the upper river bank. South of the Project Area, and extending from the top of the river bank, the upland area is largely ruderal and devoid of vegetation (WBC 2014).

2.3 Surveys for Federal Listed Species and Habitat

WRA searched the California Department of Fish and Wildlife (CDFW) Natural Diversity Database (CNDDDB; CDFW 2014) for documented occurrences of federal listed species near the Project Area. Results are presented in Figure 3.

2.4 Hydrography

The bathymetry in the Project Area tapers dramatically from the shoreline to the San Joaquin River navigation area. Water depth at the wharf is approximately 10.7 m (35 ft) Mean Higher High Water (MHHW) (WBC 2014). Current speed based on NOAA's 2014 tidal predictions for the general Project Area are a maximum ebb current of approximately 1.2 knots, and a maximum flow current of 0.7 knots (BCG 2014).

2.5 Current Operations

The Wharf currently serves as a receiving terminal for ocean going vessels offloading gypsum to the Georgia-Pacific plant. **Ships utilizing the dock to offload gypsum first approach the berth under the command of a San Francisco Bar Pilot. Once the ship has berthed, mooring lines are connected to mooring points to secure the vessel. Next, the ship's offloading conveyor is positioned over the wharf hopper. The gypsum is then offloaded and transported to the plant dome storage. Once the gypsum offloading is completed, the mooring lines are released and the vessel departs the berth.**

Specific vessel size used for gypsum delivery is determined by the contracted ocean shipping line. This has resulted in the vessel size currently calling upon the Wharf to vary, as Georgia-Pacific has no control over what vessel is used to deliver the gypsum shipments. For several years, the trend in vessels arriving at the Wharf has been an increase in vessel size, as shipping line companies deliver shipments to more than one location on each trip. Previously,

Georgia-Pacific occasionally received a 804 ft vessel, which is the largest size vessel to call at the Wharf past or present, but typically received vessels closer to 600 ft. The smaller 600 ft vessels have been retired and are now replaced with 750 ft vessels. So, instead of an occasional 804 ft vessel and typical 600 ft vessels, the Wharf will now see an occasionally 804 ft vessel and typical 750 ft vessels.

Despite this increase in vessel size, existing channel depth restrictions near the Wharf limits the draft on vessels, as the larger vessels offload cargo at other terminals prior to approaching the Wharf. The amount of gypsum the Georgia-Pacific plant receives will not increase with the Action, as the volume of gypsum that can be stored at the Georgia-Pacific plant is limited by the size of the storage dome. The vessel size, draft, and the amount of traffic that will utilize the Wharf will remain the same as current operations following the completion of the Project. There is no planned dredging for the Wharf, and there is no known dredging anticipated for the federally maintained navigation channel. The Action will result in no change in current terminal capacity or service.

3.0 DESCRIPTION OF THE ACTION TO BE CONSIDERED

3.1 Description of General Activities

General activities involve structural upgrades of the mooring and berthing system that are required to assure structural integrity and seismic stability consistent with MOTEMS requirements and to continue accommodating existing larger vessels currently calling on the Wharf.

3.2 Delineation of Action Area

The Action Area is defined in 50 CFR § 402.02 as, "all areas to be affected directly or indirectly by the Federal Action and not merely the immediate area involved in the action." The delineation of the Action Area accounts for effects associated with ground disturbance, changes to surface water and ground water quantity and quality, air quality effects, lighting effects, and noise disturbance.

For the six aquatic species, managed by NMFS and USFWS, the Action Area includes the location of the proposed mooring and berthing replacement and wharf repair and approximately 1,970 meters¹ radius around the work area (Figure 4). It is anticipated that West Island would act as a barrier to underwater sound generated as a result of the Project, and would therefore prevent the southeast portion of Sherman Island from being affected. Table 2 provides the area for the aquatic Action Area, and more specific areas of Action activity within the aquatic

¹ The NOAA Fisheries spreadsheet introduces the concept of "effective quiet." This concept assumes that energy from pile strikes that is less than 150 dB-SEL does not accumulate to cause injury. For any given condition, at some distance, sound attenuates to the level of effective quiet (i.e., 150 dB-SEL). The distance to a 150 dB-SEL for the largest pile being driven with the use of sound attenuation devices was assessed in Illingworth & Rodkin, Inc. (2014) *Georgia-Pacific Antioch Terminal Breasting Dolphin Replacement Project Underwater Noise Assessment*. This distance is considered the full extent for potential impact of the proposed project.

environment. Additional information on unattenuated, or worst case scenario, hydroacoustic Action Areas are presented in Appendix C.

Table 2. Aquatic Action Area Details

Area	Acreage	Square Feet	Radius (meters)*	Description
Action Area	776.82	33,838,223	1,970	The anticipated maximum distance for 150 dB using attenuation; discussed in greater detail and shown on Fig 4 of the Biological Assessment (BA).
Acoustic Impact Area	49.07	2,137,672	275	The anticipated maximum distance for cumulative SEL of 183 dB using attenuation; discussed in greater detail and shown on Fig 4 of BA.
10m Buffer From Pile Driving Locations	1.18	51,448	10	The anticipated maximum distance for 206 dB using attenuation; 10m buffer applied around each pile driving location.
Above water work - demolition	7.91	344,560	60	Maximum area anticipated for wharf demolition and barge/tug support work area.
Above water work – new construction	6.73	293,302	60	Maximum area anticipated for new construction and barge/tug support work area.

*= Parts of a buffer that extends onto the shore (i.e. out of the channel) was not included in the area calculation as the impact to federal species is aquatic based

For the one terrestrial species managed by USFWS, an additional terrestrial Action Area is provided that includes the wharf repair area and an acoustic radius modeled from sound levels anticipated from impact hammer driving traveling 548 m (1,800 ft) before ambient levels would be reached². This distance was used to identify a terrestrial acoustic Action Area, which encompasses 318 acres over water and land (Appendix B, Supplemental Figure 1). When in a direct line of sight to the pile, sound within the terrestrial Action Area is anticipated to be above ambient conditions during impact hammer driving.

3.3 Specific Action Description

The structural upgrade of the Wharf will involve replacing five of the existing timber breasting and mooring dolphins by constructing new breasting dolphins and mooring dolphins to meet the state engineering requirements of the CSLC Marine Facilities Division, and to continue safely accommodating larger vessels that are delivering gypsum to the plant under current shipping contracts. There will be no expansion of the existing wharf offloading or storage capacity.

² Draft Antioch Wharf Initial Study. 2014. Noise

Project activities will include both in-water work (pile removal and pile driving) and over-water work (wharf demolition, new dolphin and walkway construction, and timber repairs), and is described in more detail below.

The wharf upgrade plan entails demolition of five (5) of the existing timber breasting and mooring dolphins (containing a total of 150 14-inch diameter creosote treated timber piles) and replacement by construction of four (4) new breasting dolphins, each with a cone fender system, and three (3) new mooring dolphins, with connecting walkways (Figure 2 and Figure 5). The new dolphins will be hollow core steel monopiles: breasting dolphins at 72-inch diameter with tip elevations of about minus 97 ft (installed about 65 ft below the mudline); mooring dolphins at 42-inch to 48-inch diameter with tip elevations of about minus 56 to minus 61 ft (installed at about 51 to 56 ft below the mudline); and walkway support piles at 24-inch to 30-inch diameter with tip elevations about minus 43 to minus 67 ft (installed about 38 to 48 ft below the mudline). Removal of existing creosote treated timber piles will occur with a clamshell buck or a chain. **If a pile breaks above the mudline, the remaining piece will be reconnected to and removed, likely using a clamshell bucket's jaws to grab the pile. The remaining portion of the pile will then be removed to below the mudline. No water jetting is proposed for use during pile removal.**

Construction will be entirely supported from barges moored in the water. Construction activities and materials will be staged from barges anchored close to the specific work. Two general types of barges will be used during construction – material barges and derrick barges. Material barges typically have a flat deck for optimal loading of materials. These barges will store construction materials such as timber, steel piles, precast concrete, fenders, and handrail and will be secured to the derrick barges. Derrick barges are equipped with revolving cranes built into the barge that will be used for pile driving and removal, and are connected to mooring anchors and spuds used to secure the floating equipment into place during construction. Barges will be positioned around the wharf by tugboats.

All demolition and construction activities are anticipated to occur between August 1 and **November 30, 2015**. During this period, an estimated 24 days of in-water construction is planned. **Within the work window, impact pile driving for the Project will only occur between October 1 and November 30, 2015.** The Action will involve a one-time short duration construction event, and no ongoing project related activity is anticipated.

The original solid deck walkways of the Wharf will be replaced with new light permitting walkway decks constructed of grip strut type planking (expanded metal grating). The total shadowed area has been reduced by 157 square ft by narrowing the walkways. The reduced shadow walkway area extends an estimated 830 square ft over river water at about 9 ft depth or less (< 0.02 acre) and extends an estimated total of 1475 square ft over river water at about 20 ft depth or less (~ 0.03 acre).

Sea-level rise was assessed for the functional lifetime of the rehabilitated Wharf, and this aspect was included in the Project design basis (BCG 2014). The Project engineer's design estimate for the mean sea-level change is based on the "State of California sea level rise interim guidance document" (2010), developed by the Sea-Level Rise Task Force of the Coastal and Ocean Working Group of the California Climate Action Team, with science support provided by the Ocean Protection Council's Science Advisory Team and the California Ocean Science Trust. While the design life of the Wharf is 25 years, the service life is assumed to extend till 2070, about 55 years from construction. During this period, sea-level rise of approximately 2.0 ft is

assumed. Modeling the projected sea-level rise, the estimated 25 year significant wave of 2.5 ft for this location, and MHHW; there would still be about 4.0 ft of clearance between the water and the deck. The fenders have been located at an elevation that is compatible with current as well as future water levels. Additionally, all of the steel components in or near the splash zone are specified to have coatings or galvanizing to protect them from corrosion.

During a routine above-water inspection to verify geometry for design, damage to an existing timber pile and approximately 12 existing timber stringers was noted. To mitigate the damage to the timber pile, GP plans to install a fiberglass sleeve around the damaged pile and fill the annulus with cementitious grout. The addition of new stringers adjacent to the damaged stringers is also planned so that the new stringers can transfer the load to the cap beams below. Repairs to the structure will happen concurrently with the construction of the replacement portions of the wharf.

3.4 Pile Driving Activities

The contractor and Applicant's engineer anticipate using vibratory and impact hammers to drive the piles. It is estimated that each pile will require approximately 15 minutes of vibratory driving and 100 to 700 blows with an impact hammer to drive the piles to their final elevation (Illingworth & Rodkin 2014). It is anticipated that an APE 400 vibratory hammer and a Delmag D160 diesel impact hammer would be required to drive the 42-inch, 48-inch, and the 72-inch piles; while the 24-inch and the 30-inch walkway piles will be installed using an ICE 44 vibratory hammer and a Delmag D62 diesel impact hammer (Illingworth & Rodkin 2014).

For the vibratory hammer, each pile is estimated to be driven 30 ft in approximately 15 minutes. Impact hammer driving would then be used until the pile reaches its required depth, and is anticipated to result in 20 blows per foot. The project is anticipated to install one (1) pile per day for the 72-inch piles and up to two (2) piles per day for all other piles. An estimated 24 days of in-water construction is planned. **All pile driving activities are anticipated to occur between October 1 and November 30, 2015.** A description of the type of pile to be driven and their location is provided in Table 3 and Figure 5.

Table 3. Summary of Pile Driving Activity.*

Location Name		Total Pile Quantity	Diameter (inches)	Pile Embedment Depth (feet)	Estimated Number of Pile Strikes
Breasting Dolphin Piles	BD1, BD2, BD3, BD4	4	72	65	700
Mooring Piles	MD1, MD2	2	42	51	420
	MD3	1	48	56	520
Walkway Piles	WB1	1	24	38	160
	WB2, WB6	2	24	48	360
	WB3, WB4, WB5	3	30	35	100

* Table modified from Illingworth & Rodkin 2014

3.5 Avoidance and Minimization Measures

The applicant proposes a number of avoidance and minimization measures to reduce the potential for take of listed fish species. Prior to construction, a construction employee education program will be conducted to discuss potential listed species on the site. At minimum, the program will consist of a brief presentation by persons knowledgeable in listed species biology and legislative protection to those personnel performing in-water work within the Action Area. Contractors, their employees, and agency personnel will undergo sensitive species training prior to involvement with construction activities in the Project Area. The program will include the following:

- A description of the species and their habitat needs,
- Reports of occurrences in the Project Area,
- An explanation of the status of each listed species and their protection under the ESA, and
- A list of measures being taken to reduce potential effects to the species during construction and implementation.

Fact sheets conveying this information will be prepared for distribution to the above-mentioned people and anyone else involved with in-water work activities in the Project Area. Records of sensitive species training will be retained by the approved biologist.

For all work being performed:

- 1) Standard construction best management practices (BMPs) will be implemented during demolition and construction. BMPs used on site will include:
 - a) A Spill Prevention and Control Plan will be developed and will contain measures to prevent and control potential spills of hazardous materials associated with mechanical equipment (oil, gas, hydraulics, etc.), as well as measures to minimize contact with the stream bed, such as work pads. The Plan and materials necessary to implement it will be accessible on site;
 - b) A debris containment boom will be installed around the work area. Any debris discharged into water will be recovered immediately.

Methods proposed for use during above-water construction for the avoidance and minimization of potential hydroacoustic effects to Lange's metalmark butterfly include:

- 1) Impact pile driving will not occur from August 1 through September 29 to correspond with the adult flight season and survey period.**

Methods proposed for use during in-water construction for the avoidance and minimization of potential hydroacoustic effects to fish include:

- 2) All in-water work shall be performed within the environmental work window for the San Francisco Bay Delta between August 1 and November 30.

- 3) A vibratory hammer will be used to start the installation of each pile, and will continue as long as geotechnical conditions permit. Vibratory hammer use will be conducted without sound attenuation minimization measures.
- 4) Underwater sound monitoring shall be performed during pile driving activities. Accumulated sound exposure levels (SEL) shall adhere to the incidental take SEL limits permitted by NMFS and USFWS. All incidents of exceedance of the SEL standard shall be reported to the permitting agency within 24 hours. Underwater sound reduction measures will include one or more of the following:
 - a) use of a bubble curtain surrounding piles during pile driving operations;
 - b) use of an impact hammer cushion block;
 - c) use of impact hammers only during daylight hours;
 - d) gradually increasing energy and frequency of impacts to permit wildlife to vacate the surrounding area; and
 - e) installation of pipe caisson with a vibratory hammer to isolate piles from the water column.
- 5) A qualified biologist will monitor pile driving activity. Any injury or mortality of listed fish, along with the SEL, will be reported to the permitting agency within 24 hours.
- 6) All water quality protection requirements identified in the 401 certification for the Project will be followed.

4.0 STATUS OF THE SPECIES AND CRITICAL HABITAT IN THE AREA

The life history information presented below is largely taken from the *Supplemental Biological Opinion for the Completion of Pile Driving and Other Remaining Activities* (NMFS, Southwest Region, August 21, 2009) and further informed by the Services Reinitiation of Formal Endangered Species Consultation and Amendment to the Biological Opinion (File # 1-1-96-F-40) for the New Benicia Martinez Bridge Project (January 9, 2001), the 2008 Formal Endangered Species Act Consultation on the Proposed Coordinated Operations of the Central Valley Project and State Water Project, and the 2001 NMFS Biological Opinion for the San Francisco-Oakland Bay Bridge East Span Seismic Project.

4.1 General Life History for Green Sturgeon

The Southern Distinct Population Segment (DPS) of green sturgeon was listed as threatened by the NMFS on April 7, 2006 (71 FR 17757). Critical habitat for the species was designated on October 9, 2009 (74 FR 52300). A 5-year status review of green sturgeon was completed on October 24, 2012; that review affirmed the need to retain green sturgeon as a threatened species.

Like all sturgeon, North American Green sturgeon are anadromous, long-lived, and a slow growing species (Adams et al. 2002). Along the Pacific Coast, North American Green sturgeon have been documented offshore from Ensenada, Mexico to the Bering Sea, Alaska and found in freshwater rivers from the Sacramento River to British Columbia (Moyle 2002). Two DPS of

green sturgeon have been identified along the western coast of North America, and are known to occur in near shore marine waters, and are commonly observed in coastal bays, estuaries, and coastal marine waters from southern California to Alaska (Lindley et al. 2008). Of the two DPS, only the southern DPS is listed as a threatened species under the ESA. The southern DPS is designated as populations originating from coastal watersheds south of the Eel River (California) where the only known spawning population is in the Sacramento River (50 CFR part 226).

The life cycle of southern DPS green sturgeon can be broken into four distinct phases based on developmental stage and habitat use: (1) larvae and post-larvae less than 10 months of age; (2) juveniles less than or equal to three or four years of age; (3) coastal migrant females between three or four and thirteen, and males between three or four and nine years of age; and (4) adult females greater than or equal to thirteen years of age and males greater than or equal to nine years of age (Nakamoto et al. 1995).

Confirmed spawning populations of North American green sturgeon currently are found in only three river systems, the Sacramento and Klamath Rivers in California, and the Rogue River in southern Oregon (Erickson et al. 2002, Farr and Kern, 2005). During the late summer and early fall, sub-adults and non-spawning adult Green sturgeon frequently can be found aggregating in estuaries along the Pacific coast (Emmett et al. 1991). Relatively large concentrations occur in the Columbia River estuary, Willapa Bay and Grays Harbor, with smaller aggregations in San Francisco Estuary (Emmett et al. 1991, Moyle et al. 1992).

Green sturgeon may migrate long distances upstream to reach spawning habitat. Southern DPS green sturgeon adults typically begin their upstream spawning migrations into the San Francisco Bay by late February to early March, reach Knights Landing by April, and spawn between March and July (Heublein 2006). Peak spawning is believed to occur between mid-April to mid-June and thought to occur in deep, fast water (> 3 m), of large rivers (Emmett et al. 1991, Adams et al. 2002). Recent data regarding adult southern DPS green sturgeon has been collected from monitors located from the Golden Gate Bridge to the upper Sacramento River. Some fish that entered the estuary continued to the Sacramento River to spawn. Spawning has been documented on the mainstem over 240 miles upstream, both upstream and downstream of the Red Bluff Diversion Dam (Brown, 2007). Based on the distribution of sturgeon eggs, larvae, and juveniles in the Sacramento River, CDFG (2002) indicated that southern DPS green sturgeon spawn in late spring and early summer above Hamilton City possibly to Keswick Dam.

Adults captured in the Sacramento-San Joaquin Delta are known to feed on invertebrates such as shrimp, mollusks, amphipods, and additionally upon small fish (Adams et al. 2002). Juvenile green sturgeon in the San Francisco Estuary have been shown to feed on opossum shrimp (*Neomysis mercedie*) and amphipods (*Corophium spp.*) (Moyle 2002). Juvenile distribution and habitat use is still largely unknown, and juveniles are presumed present year round in all parts of the San Francisco Bay Estuary (Israel and Klimley 2008).

The waters adjacent to the Project Area provide a migratory corridor, and possibly rearing habitat for this species. Spawning habitat is not supported in the area; however, the species may still occur seasonally. Additionally, the Project Area contains critical habitat for this species.

4.2 General Life History for Chinook Salmon

There are two Evolutionarily Significant Units (ESU) of Chinook salmon designated for protection under the ESA. The Sacramento River winter-run Chinook salmon was reclassified from threatened to endangered by NMFS on January 4, 1994 (59 FR 440) and was reaffirmed as endangered on June 28, 2005 (70 FR 37160). Critical habitat for the species was originally designated on June 16, 1993 (58 FR 33212). The Central Valley spring-run Chinook salmon was listed as threatened by NMFS on September 16, 1999 (64 FR 50394) and was reaffirmed on June 28, 2005 (70 FR 37160). Critical habitat for spring-run Chinook salmon was designated on September 2, 2005 (70 FR 52488).

Chinook salmon runs are designated on the basis of adult migration timing; however, distinct runs also differ in the degree of maturation at the time of river entry, thermal regime and flow characteristics of their spawning site, and actual time of spawning (Myers et al. 1998). Both winter-run and spring-run Chinook salmon tend to enter freshwater as immature fish, migrate far upriver, and delay spawning for weeks or months. For comparison, fall-run Chinook salmon enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas on the mainstem or lower tributaries of rivers, and spawn within a few days or weeks of freshwater entry (Healey 1991). Adult Sacramento River winter-run Chinook salmon enter San Francisco Bay from November through June (Hallock and Fisher 1985), and delay spawning until spring or early summer. Adult Central Valley spring-run Chinook salmon enter the Sacramento Delta beginning in January and enter natal streams from March to July (Myers et al. 1998). Central Valley spring-run Chinook salmon adults enter freshwater in the spring, hold over summer, and spawn in the fall. Central Valley spring-run Chinook salmon juveniles typically spend a year or more in freshwater before migrating toward the ocean. Adequate in-stream flows and cool water temperatures are more critical for the survival of Central Valley spring-run Chinook salmon due to over-summering by adults and/or juveniles.

Sacramento River winter-run Chinook salmon spawn primarily from mid-April to mid-August, peaking in May and June, in the Sacramento River reach between Keswick Dam and the Red Bluff Diversion Dam. Central Valley spring-run Chinook salmon typically spawn between September and October depending on water temperatures. Chinook salmon generally spawn in gravel beds that are located at the tails of holding pools (USFWS 1995). Eggs are deposited within the gravel where incubation, hatching, and subsequent emergence take place. The length of time required for eggs to develop and hatch is dependent on water temperature, and quite variable. Sacramento River winter-run Chinook salmon fry (newly emerged juveniles) begin to emerge from the gravel in late June to early July and continue through October (Fisher 1994). Central Valley spring-run Chinook salmon fry emerge from November to March and spend about 3 to 15 months in freshwater prior to migrating towards the ocean (Keljson et al. 1981). Post-emergent fry seek out shallow, near shore areas with slow current and good cover, and begin feeding on small terrestrial and aquatic insects and crustaceans.

In the Sacramento River and other tributaries, juveniles often migrate downstream from December through March (Moyle 2002). Fry may spend time rearing within riverine and/or estuarine habitats including natal tributaries, the Sacramento River, non-natal tributaries to the Sacramento River, and the Delta. Within estuarine habitat, juvenile Chinook salmon movements are generally dictated by tidal cycles, following the rising tide into shallow water habitats from the deeper main channels, and returning to the main channels when the tide recedes (Levy and Northcote 1982; Levings 1982; Healey 1991). Juvenile Chinook salmon

forage in shallow areas with protective cover, such as intertidal and subtidal mudflats, marshes, channels and sloughs (McDonald 1960, Dunford 1975).

As juvenile Chinook salmon increase in length, they tend to school in the surface waters of the main and secondary channels and sloughs, following the tides into shallow water habitats to feed (Allen and Hassler 1986). Keljson et al. (1981) reported that juvenile Chinook salmon demonstrated a diel migration pattern, orienting themselves to near shore cover and structure during the day, but moving into more open, offshore waters at night. The fish also distributed themselves vertically in relation to ambient light. During the night, juveniles were distributed randomly in the water column, but would school up during the day into the upper three meters of the water column. Juvenile Sacramento River winter-run Chinook salmon migrate to the sea after only rearing in freshwater for four to seven months, and occur in the delta from October through early May (CDFG 1998). Most Central Valley spring-run Chinook salmon smolts are present in the delta from mid-March through mid-May depending on flow conditions (CDFG 2000).

The waters adjacent to the Project Area provide a migratory corridor and juvenile rearing and foraging habitat for spring-run Chinook salmon, and potential rearing habitat for winter-run Chinook salmon. Spawning habitat is not supported in the area; however, each species may still occur seasonally. The Project Area does not contain critical habitat for either ESU of this species.

4.3 General Life History for Steelhead

The Central Valley Distinct Population Segment (DPS) of steelhead was originally designated as threatened by NMFS on March 19, 1998 (63 FR 13347) and was reaffirmed on January 5, 2006 (71 FR 834). Critical habitat for the species was designated on September 2, 2005 (70 FR 52488).

Steelhead are an anadromous form of *Oncorhynchus mykiss*, spending some time in both freshwater and saltwater. The older juvenile and adult life stages occur in the ocean, until the adults ascend freshwater streams to spawn. Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death (Busby et al. 1996). Eggs (laid in gravel nests called redds), alevins (gravel dwelling hatchlings), fry (juveniles newly emerged from stream gravels), and young juveniles, remain in freshwater until they become large enough to migrate to the ocean to finish rearing and maturing to adults. General reviews for steelhead in California document much variation in life history (Barnhart 1986, Busby et al. 1996, McEwan 2001). Although variation occurs, steelhead usually live in freshwater for two years, then spend one or two years in the ocean before returning to their natal stream to spawn.

Steelhead from the tributaries of San Francisco Bay, typically migrate to freshwater between November and April, peaking in January and February. They migrate to the ocean as juveniles from March through June, with peak migration occurring in April and May (Fukushima and Lesh 1998). Steelhead fry generally rear in edgewater habitats and move gradually into pools and riffles as they grow larger. Cover is an important habitat component for juvenile steelhead, both as a velocity refuge and as a means of avoiding predation (Shirvell 1990, Meehan and Bjorn 1991). Steelhead, however, tend to use riffles and other habitats not strongly associated with cover during summer rearing more than other salmonids. Young steelhead feed on a wide variety of aquatic and terrestrial insects, and emerging fry are sometimes preyed upon by older juveniles. Rearing steelhead juveniles prefer water temperatures of 7.2-14.4 degrees Celsius

(C) and have an upper lethal limit of 23.9 C (Barnhart 1986, Moyle 2002). They can survive in water up to 27 C with saturated dissolved oxygen conditions and a plentiful food supply. Fluctuating diurnal water temperatures also aid in survivability of salmonids (Busby et al. 1996).

Juvenile steelhead emigrate episodically from natal streams during fall, winter, and spring high flows. Emigrating Central Valley steelhead use the lower reaches of the Sacramento-San Joaquin Rivers and the Delta for rearing and as a migration corridor to the ocean. Barnhart (1986) reported that steelhead smolts in California range in size from 140 to 210 millimeter (mm) fork length. Juvenile steelhead in the Sacramento River Basin migrate downstream during most months of the year, but the peak period of emigration occurs in the spring, with a much smaller peak in the fall.

The waters adjacent to the Project Area provide a migratory corridor and juvenile rearing and foraging habitat for this species. Spawning habitat is not supported in the area; however, the species may still occur seasonally. Additionally, the Project Area contains critical habitat for this species.

4.4 General Life History for Delta Smelt

The USFWS proposed to list the Delta smelt as threatened with proposed critical habitat on October 3, 1991 (56 FR 50075). The USFWS listed the Delta smelt as threatened on March 5, 1993 (58 FR 12854), and designated critical habitat for this species on December 19, 1994 (59 FR 65256). The Delta smelt was one of eight fish species addressed in the Recovery Plan for the Sacramento–San Joaquin Delta Native Fishes (USFWS 1995). A 5-year status review of the Delta smelt was completed on March 31, 2004; that review affirmed the need to retain the Delta smelt as a threatened species.

The Delta smelt is a member of the Osmeridae family (northern smelts) (Moyle 2002) and is one of six species currently recognized in the *Hypomesus* genus (Bennett 2005). The Delta smelt is endemic to the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta) in California, and is restricted to the area from San Pablo Bay upstream through the Delta in Contra Costa, Sacramento, San Joaquin, Solano, and Yolo counties (Moyle 2002). Their range extends from San Pablo Bay upstream to Verona on the Sacramento River and Mossdale on the San Joaquin River. The Delta smelt was formerly considered to be one of the most common pelagic fish in the upper Sacramento- San Joaquin Estuary. While aspects of this species life history are known, certain key components of wild fish, such as spawning habitat requirements and locations are less well known and often inferred by laboratory observations, trawl and sample catch locations of spent females and young larvae, and comparisons with similar species (USFWS 2008).

Delta smelt are euryhaline species that generally occur in water with less than 10-12 parts per thousand (ppt) salinity, although they have been collected in San Pablo Bay at 18.5 ppt and in the Carquinez Strait at 13.8 ppt. Collection activities tend to indicate that Delta smelt can spawn in temperatures ranging from 7 to 22 degrees Celsius. Delta smelt tend to be concentrated near the zone where out flowing fresh water and incoming salt water mix (mixing zone). The species inhabit open surface waters of the Delta and Suisun Bay. Delta smelt are found at all life stages in greatest abundance in the top 2 meters of the water column and usually not in close association with the shoreline (USFWS 2004). Delta smelt usually aggregate but do not appear to be a strongly schooling species. Genetic analyses have confirmed that *H. transpacificus* presently exists as a single intermixing population (Trenham et al. 1998).

Spawning occurs in shallow water habitats in the Delta. Adult smelt migrate upstream from brackish water habitat associated with the mixing zone before spawning to disperse into river channels and tidally influenced backwater sloughs. The spawning season varies from year to year, between late winter (December) to early summer (July). Laboratory observations have indicated that Delta smelt are broadcast spawners with sinking (demersal) eggs with adhesive properties. It is postulated that the eggs sink and attach to substrates like tules, tree roots and other submerged vegetation in shallow waters (USFWS 2004). Newly hatched and juvenile Delta smelt forage in shallow waters until they reach 16 to 18 mm in length. Once they develop a swim bladder, they rise up higher into the water column and are washed downstream into the mixing zone. By August juvenile smelt are typically 40-50 mm (USFWS 2004).

Delta smelt feed on planktonic copepods, small crustaceans, amphipods, and to a lesser extent insect larvae. They are fed upon by subadult striped bass (*Morone saxatilis*) and have been found in the stomach contents of black crappie (*Pomoxis nigromaculatus*) and white catfish (*Ameiurus catus*) (USFWS 2004).

This species is known to occur in the waters adjacent to the Project Area; however, shallow water spawning habitat does not occur in or adjacent to the Project Area. The Project Area provides habitat for adult and juvenile Delta smelt. Additionally, the Project Area contains critical habitat for this species.

4.5 General Life History for Longfin Smelt

On August 8, 2007 the USFWS was petitioned to add the longfin smelt to the list of Threatened and Endangered Species. During the most recent review by the USFWS it was determined that the San Francisco Bay-Delta DPS of longfin smelt warranted protection under the Endangered Species Act. However, the USFWS has not yet listed the species, and it remains a candidate species at the federal level (USFWS 2013a).

The longfin smelt is an anadromous fish found in California's bay, estuary, and nearshore coastal environments. The range of longfin smelt extends along the Pacific coast of North America from the Sacramento-San Joaquin estuary in California, north to the Gulf of Alaska. Outside of California the species primarily exists in scattered and isolated bays or estuaries (Moyle 2002). The San Francisco Estuary supports the southern-most longfin smelt population, and the largest population in California (Moyle 2002). Longfin smelt are known to inhabit the entire San Francisco Estuary, including portions of the Napa River, Suisun and Napa marshes, and the Sacramento-San Joaquin Delta (CDFW 2009).

This species is a member of the Osmeridae family (Moyle 2002). Most notably, they are distinguished from other smelts by the large pectoral fins for which they are named. Lifespan of the species is generally two years, but three-years-old smelt have been observed (CDFW 2009). Longfin smelt reach 6-7 cm SL in the first 9-10 months of life. Growth is minimal during their first winter, but the growth rate increases again in their second summer and fall when they reach 9-11 cm SL. The largest members of the species are female fish that may reach up to 15 cm in their third year (Calfish 2014).

The species can tolerate salinities ranging from freshwater to nearly pure seawater. Most longfin smelt occupy the middle or bottom of a water column and tend to favor temperatures in the range of 16-18°C and salinities ranging from 15-30 ppt (Calfish 2014). While longfin smelt encounter a wide variety of water temperatures, and salinities during their life cycle, they are

rarely found in water temperatures greater than 22°C (CDFW 2009). Their spatial distribution within a bay or estuary is seasonally variable based on these temperature and salinity tolerances. Longfin smelt can also make daily migrations; remaining deep during the day and rising to the surface at night. Avoiding surface waters during the day helps them avoid predation from birds, marine mammals, and other fish (Calfish 2014). Generally speaking longfin smelt are found closer to the ocean during summer and move into streams during winter months for spawning (Baxter 1999).

Spawning occurs between February and April when fish move into freshwater streams and rivers (Calfish 2014). Spawning areas are generally gravel or sandy substrate where rocks and aquatic plants are present. Spawning occurs at night, and after fertilization, the eggs adhere to plants and gravel in the area. Eggs typically hatch at around 40 days. Winter and spring outflows transport recently hatched larvae downstream to Suisun Bay, San Pablo Bay, and San Francisco (Baxter 1999).

As juveniles longfin smelt feed on copepods and cladocerans. With subsequent growth their diet expands to include mysids and amphipods (CDFW 2009). Longfin smelt are an important prey species and are fed upon by many species of predatory fish. However, striped bass (*Morone saxatilis*) are a dominant predator of longfin smelt in the San Francisco Bay area (CDFW 2009). The other primary threats to the San Francisco Bay population are due mainly to the effects of water diversions from the Delta (Moyle 2002).

This species is known to occur in the waters adjacent to the Project Area; however, shallow water spawning habitat does not occur in or adjacent to the Project Area. The Project Area provides habitat for juvenile rearing and adult migration. Critical habitat for this species has not been designated.

4.6 General Life History for Lange's Metalmark Butterfly

The USFWS listed Lange's metalmark butterfly (LMB) as endangered on June 1, 1976 (41 FR 22041 22044). Critical habitat for the species was proposed February 8, 1977 (42 FR 7972 7976); however was never formally designated. LMB is one of three species addressed in the Revised Recovery Plan for Three Endangered Species Endemic to Antioch Dunes, California (USFWS 1984). A 5-year status review of LMB was completed on July 10, 2008; that review affirmed the need to retain the LMB as an endangered species.

LMB is endemic to California, persisting in the wild only in the 67-acre Antioch Dunes National Wildlife Refuge (ADNWR), **and on sand dune habitat immediately adjacent to the ADNWR.** LMB inhabits stabilized dunes and the species' life cycle is closely tied to its larval food plant, naked stemmed buckwheat (*Erigonum nudum auriculatum*). **As communicated by ACOE, the USFWS presumes presence of LMB where naked stemmed buckwheat occurs (correspondence with ACOE May 29, 2015 and June 12, 2015).** This area includes ADNWR and areas immediately to the west (PG&E parcel) and east of the Sardis Unit, as shown in the mapped density of buckwheat in Supplemental Figure 2 (Appendix B). **Based on the USFWS 2006 buckwheat density figure, naked stemmed buckwheat occurs in small low density patches in the eastern part of the Georgia-Pacific property. Georgia-Pacific however does not have any knowledge of the locations where the naked-stemmed buckwheat occurs on their property, and no members of the genus *Erigonum* were observed during a 2014 survey of habitat adjacent to the Project Area (WBC 2014).** The area USFWS mapped with buckwheat is outside of the Project Area (Figure 2).

Adults begin to emerge in early August and the mating flight season can last until mid to late September, a period of approximately seven weeks (USFWS 1984, Johnson et al. 2007). Peak flight season usually occurs in the last week of August and first week of September (Johnson et al. 2007). Butterflies of both sexes live for approximately one week, and feed on the nectar of the buckwheat as well as on butterweed (*Senecio flaccidus* var. *douglasii*), San Joaquin snakeweed (*Gutierrezia californica*), and silver lupine (*Lupinus albifrons*). **Most male LMB are believed to travel only a short distance, less than 90 feet, and female LMB are believed to travel up to 1,200 feet in search nectar plants and buckwheat (correspondence from ACOE on May 29, 2015 and June 2, 2015).** During the flight season, eggs are laid on buckwheat stems. The eggs remain dormant until the rainy season and then the hatched larvae feed on new buckwheat growth during winter and spring. The caterpillars pupate in mid-summer at the base of the buckwheat.

Threats to this species include habitat loss and modification, invasive exotic vegetation, industrial development, wildfires, and herbicides. Historic sand mining initially fragmented and destroyed much of the natural dune habitat in the region. Wildfire, construction, and agricultural activities also contributed to additional habitat loss. Currently, invasive plant species have stabilized the dune structure, inhibiting the growth of the buckwheat, which needs open sand to become established. **Fixation of nitrogen emissions in dune habitats also encourages the growth of invasive plants, which exclude the buckwheat, which has been identified as a threat by USFWS from the nearby Oakley Generating Station (USFWS 2010).** Herbicides used to remove invasive plants from the dunes may affect LMB pupation or have effects on food plant quality. **USFWS has identified gypsum dust as a possible low level threat to LMB eggs, larvae, and host plants; however, there is no evidence, let alone available data, nor research to support dust adversely affecting LMB or their host plant (USFWS 2008, Richmond et al. 2015).** A ranking of 17 threats, in order of decreasing importance, identified invasive grasses and forbs and demographic stochasticity as the greatest threats to LMB and gypsum (dust) and butterfly diseases as the least important threats (Richmond et al. 2015). **The complete threat list to LMB, ranked by USFWS and reported in Richmond et al. (2015) in importance from the greatest threat to the least threat, is:**

- 1) Invasive grasses and forbs;
- 2) Demographic stochasticity;
- 3) Altered substrate (i.e. reduced open sand areas);
- 4) Nitrogen deposition;
- 5) Wildfire;
- 6) Climate change;
- 7) Altered disturbance regime;
- 8) Loss of nectar plants;
- 9) Increased woody vegetation;
- 10) Vector control;
- 11) Dispersal limitation;
- 12) Development;
- 13) Floristic diversity;
- 14) Host plant disease;
- 15) Predation/parasites;
- 16) Gypsum; and
- 17) Butterfly disease.

Recovery of the LMB has been aided through a catch and release propagation program which began in August 2007. This collaborative program serves as an insurance against extinction, and includes the USFWS and the LMB working group. The program involves seasonal collection of adult LMB and the rearing and release of larvae back to ADNWR occur annually, along with the propagation of LMB's host plant, the naked-stemmed buckwheat. During the peak flight season in late August or early September, typically five adult females or 10% of the peak flight number are collected (Johnson et al. 2011). The collected adults are moved to Moorpark College propagation lab, where eggs are deposited on naked stemmed buckwheat. Larvae generally hatch out in February, and are reared till their release back to ADNWR, which typically occurs in late June (USFWS 2012a).

In addition to the catch and release propagation program, USFWS leads annual LMB surveys in ADNWR that began in 1986. Surveys consist of ADNWR refuge staff, interns, and volunteers and typically include five to 15 people (USFWS 2015). The survey period starts the first week of August and continues until a zero count is reached. In 2013, survey work continued until September 26th and the peak number of LMB observed was 28 individuals and a total count of 78 LMB was reported (USFWS 2014). For 2014, survey work continued until September 18th and the peak number of LMB observed was 44 individuals and a total count of 139 LMB was reported (USFWS 2015).

The aquatic based Project Area does not contain suitable habitat for LMB. **UFWS has mapped naked stemmed buckwheat within the eastern portion of the Georgia-Pacific property, and assumes presence of LMB where naked stemmed buckwheat occurs; however, this area is outside of the aquatic based Project Area.** The Project Area parcel does fall between the ADNWR; and is approximately 300 m (984 ft) from the eastern boundary of the Stamm Unit (western portion of refuge) and approximately 125 m (410 ft) from the western boundary of the Sardis Unit (eastern portion of the refuge). **Therefore, LMB does not occur within the Project Area, but does occur within the terrestrial Action Area.**

5.0 MANNER IN WHICH ACTION MAY AFFECT SPECIES AND CRITICAL HABITAT

The proposed Action is likely to adversely affect listed species that may be within the Action Area. The proposed Action is not likely to destroy or adversely modify critical habitat within the Action Area.

5.1 Analysis of Effects to Listed and Candidate Species

The following section provides an analysis of potential effects from the proposed Action on listed and candidate species.

5.1.1 Analysis of Direct Effects to Fish

Direct effects are those effects caused directly by the proposed Action that occur on-site within the Project Area and during Action implementation, i.e., ground disturbance within the Action Area.

Potential effects from in-water work to fish species from pile driving activities as well as the Action Area buffer was assessed in the Illingworth & Rodkin, Inc. (2014) *Georgia-Pacific Antioch Terminal Breasting Dolphin Replacement Project Underwater Noise Assessment*, included in

Appendix D. Pile driving produces underwater noise, which manifests as pressure waves in the aquatic environment. In order to evaluate the potential effect to fishes exposed to elevated levels of underwater sound produced during pile driving, Illingworth & Rodkin assessed the anticipated sound levels calculated from results of measurements from similar projects, along with the threshold established by the Federal Highway Administration (FHWA), California Department of Transportation (Caltrans) and NMFS.

The assessment estimates the levels of underwater sound (peak and root mean square [RMS] pressure, as well as accumulated Sound Exposure Level [SEL]) received by fishes that are exposed to elevated levels of underwater sound produced during pile driving. Distance from each pile that the sound attenuates to threshold levels was determined, and the sound impact was used to compute effects to fish species that are presumed stationary. Sound levels for both attenuated and unattenuated (i.e. no means of reducing underwater sound levels) were provided in the assessment and are addressed below, along with specific distances within which specific thresholds are exceeded. Based on past projects it is estimated that sound levels can be reduced up to 10 dB using a properly deployed attenuation device (Illingworth & Rodkin 2014). Effects are addressed as a condition where fish are assumed to be stationary relative to the pile driving.

In general, species of herring, croakers, and shad are hearing specialists while most other fish are hearing generalists (ICF Jones and Stokes, and Illingworth and Rodkin, Inc., 2009). Sound specialists are likely to be affected by sound to a greater degree than sound generalists, and smaller fish are generally more susceptible to injury from sound than larger fish (ICF Jones and Stokes, and Illingworth and Rodkin, Inc. 2009). As such, the effects that are presented in this section are presumably higher than those that will actually occur during Action activities because:

- a) impact calculations were determined using small fish and stationary fish in order to calculate a maximum potential impact area;
- b) several of the listed fish species that may occur adjacent to the Action Area use the waters predominantly as a migratory corridor or seasonally for rearing habitat and not spawning, i.e. not stationary; and
- c) the currents and river flow adjacent to the Action Area are a detriment to stationary fish activity.

The criteria used for the onset of physical injury and adverse behavioral effects are listed in the table below. The onset of physical injury uses dual criteria - peak pressure and SEL. The onset of physical injury is expected if either of these criteria are exceeded. The criterion for accumulated SEL is based upon the mass of the fishes under consideration. Because Delta smelt and longfin smelt are known to occur within the Action Area, the more conservative 183 dB SEL criterion, which applies when fish smaller than 2 grams are present, may be required

Table 4. Fish Impact Criteria

Effect	Metric	Fish mass	Threshold
Onset of physical injury	Peak pressure	N/A	206 dB (re: 1 μ Pa)
	Accumulated Sound Exposure Level (SEL)	≥ 2 g	187 dB (re: 1 μ Pa ² •sec)
		< 2 g	183 dB (re: 1 μ Pa ² •sec)
Adverse behavioral effects	Root Mean Square Pressure (RMS)	N/A	150 dB (re: 1 μ Pa)

The peak sound pressure level, average RMS sound pressure level, and SELs anticipated for impact hammer driving during the Action were predicted using near source levels for impact pile driving and NMFS practical loss sound propagation assumption. NMFS recommends using the Practical Spreading Loss model ($TL = 15 \cdot \log(R1/R0)$), unless data are available to support a different model. The extent of sound levels anticipated for the Action are provided in Table 5.

Table 5. Modeled Extent of Sound Pressure Levels from Impact Driving of One Pile³.

Modeling Scenario	Distance to Marine Mammal Acoustic Criteria in Meters			Distance to Fish Acoustic Criteria in Meters			Distance to Behavioral Zone
	RMS (dB re: 1uPa)			Peak (dB re: 1uPa)	Cumulative SEL ⁴ (dB re:1uPa-sec2)		RMS (db re:1uPa)
	Level B Harassment	Level A Injury					
	160	180	190	206	187	183	150
72-inch Piles (Pile ID: BD 1-4) Estimated 700 Pile Strikes per Pile							
Modeled Unattenuated	1,970 ⁵	130	35	30	620 ⁵	1,065 ⁵	7,630 ⁵
Assuming a 10 dB Reduction with Attenuation	510	35	<10	<10	160	275	1,970 ⁵
48-inch Pile (Pile ID: MD 3) Estimated 520 Pile Strikes							
Modeled Unattenuated	765 ⁵	50	15	15	155	265	2,955 ⁵
Assuming a 10 dB Reduction with Attenuation	200	15	<10	<10	40	70	765 ⁵
42-inch Piles (Pile ID: MD 1&2) Estimated 420 Pile Strikes per Pile							
Modeled Unattenuated	765 ⁵	50	15	15	135	235	2,955 ⁵
Assuming a 10 dB Reduction with Attenuation	200	15	<10	<10	35	60	765 ⁵
30-inch Piles (Pile ID: WB 3-5) Estimated 100 Pile Strikes per Pile							
Modeled Unattenuated	580	40	<10	15	40	70	2,255 ⁵
Assuming a 10 dB Reduction with Attenuation	150	<10	<10	<10	10	20	580
24-inch Piles (Pile ID: WB 2&6) Estimated 360 Pile Strikes per Pile							
Modeled Unattenuated	510	35	<10	<10	95	160	1,970 ⁵
Assuming a 10 dB Reduction with Attenuation	130	<10	<10	<10	25	40	510

³ Table from Illingworth & Rodkin 2014

⁴ Base on the driving of one pile. SEL criteria apply to impact pile driving events that occur during one day. See Table 5 for predicted accumulated SEL for various daily pile driving scenarios.

⁵ Distance to underwater noise thresholds is constrained by river topography

Modeling Scenario	Distance to Marine Mammal Acoustic Criteria in Meters			Distance to Fish Acoustic Criteria in Meters			Distance to Behavioral Zone
	RMS (dB re: 1uPa)			Peak (dB re: 1uPa)	Cumulative SEL ⁴ (dB re:1uPa-sec2)		RMS (db re:1uPa)
	Level B Harassment	Level A Injury					
	160	180	190	206	187	183	150
24-inch Pile (Pile ID: WB 1) Estimated 160 Pile Strikes							
Modeled Unattenuated	510	35	<10	<10	60	100	1,970 ⁵
Assuming a 10 dB Reduction with Attenuation	130	<10	<10	<10	15	25	510

Accumulated SEL levels associated with impact pile driving from the Action will vary daily and will depend on amount of pile driving. The estimated accumulated SEL levels at 10 meters distance from the pile being driven and the distance to the accumulated 187 dB and 183 dB SEL level with and without an attenuation system are provided in Table 6.

Table 6. Cumulative SEL levels at 10 meters and Distances to the 187 dB and 183 dB Cumulative SEL Criterion for Pile Driving⁶.

Modeling Scenario	Total Strikes	Attenuation	Cumulative SEL (dB) at 10 Meters	Distance to 187 dB Cumulative SEL (Meters)	Distance to 183 dB Cumulative SEL (Meters)
One 72-inch pile	700	Unattenuated	217	620 ⁵	1065 ⁵
		Attenuated	207	160	275
MD1 (42-inch) & WB1 (24-inch)	580	Unattenuated	207	145	245
		Attenuated	197	40	65
MD2 (42-inch) & WB2 (24-inch)	780	Unattenuated	208	170	290
		Attenuated	198	45	75
BD1 (72-inch) & WB3 (30-inch)	800	Unattenuated	217	585	1005 ⁵
		Attenuated	207	150	260
WB4 (30-inch) & WB5 (30-inch)	200	Unattenuated	200	60	100
		Attenuated	190	15	25
WB6 (24-inch) & MD3 (48-inch)	880	Unattenuated	209	180	315
		Attenuated	198	50	80

⁶ Table from Illingworth & Rodkin 2014

Modeling Scenario	Total Strikes	Attenuation	Cumulative SEL (dB) at	Distance to 187 dB Cumulative	Distance to 183 dB
WB5 (30-inch) & WB6 (24-inch)	460	Unattenuated	204	95	165
		Attenuated	194	25	40

Certain construction elements of the Action could create sound waves that affect fish and marine mammals. It is possible that pile installation could create sound pressure levels in excess of the 180-decibel referenced to one micropascal threshold established by the NMFS. Sound pressure levels become harmful to aquatic wildlife above this threshold. Pile driving that results in sound pressure waves outside the Project Area that exceed the 206-decibel referenced to one micropascal and accumulated sound exposure level (for multiple strikes) of 183 decibels referenced to one micropascal square-second threshold could injure nearby sensitive fish species.

The SEL values for smaller fish were used in order to determine a maximum impact area. The implementation of sound attenuation measures, which include a bubble curtain and an impact hammer cushion block, will reduce the maximum distance the 183 dB threshold would extend for the largest piles being driven from 1,065 meters down to 275 meters. The 275 meter range represents an Acoustic Impact Area (Figure 5) and any fish within that area would be subject to direct effects, or cumulative SEL impacts, of between 183 and 187 dB. The distance where adverse behavioral effects may occur would also be diminished through the use of sound attenuation devices. As identified in Table 5, attenuation will reduce the maximum distance the 150 dB threshold would extend for the largest piles being driven from 7,630 meters down to 1,970 meters. The 1,970 meter range represents the full extent of the Action Area, as fish outside of this range are not anticipated to be effected by the Action.

In addition to the sound attention usage, a soft start will be used at the start of each day pile driving occurs or following a break of one hour or longer in pile driving. The soft start involves the gradual increase of energy and frequency of impacts to permit wildlife to vacate the surrounding area. Because special status fish within the Action Area will be mobile juveniles or adults (as opposed to eggs or larvae which tend to be subject to drift and are not freely mobile), they will have the opportunity to vacate the Acoustic Impact Area before peak sound levels occur.

Utilizing the outlined avoidance and minimization levels is anticipated to reduce sound levels during impact pile driving to levels at or below the 206 dB peak criteria. The cumulative SEL however is still anticipated to exceed the 183 and 187 dB criteria. To reduce the effect of any potential exceedance the cumulative SEL will have, work will be restricted to an environmental work window of August 1 to November 30. The work window is informed by NMFS, USFWS, and CDFW recommendations for avoidance of potential impacts to fish species in this region of the San Francisco Bay Delta. In-water work conducted within the work window will minimize the possibility that work activities may affect fish species as listed fish species are less likely to utilize the Action Area for rearing or migration during this period, and are less likely to occur in a more sensitive life stage (i.e. egg or larvae). Additionally, hydroacoustic and biological monitoring will be conducted during pile driving activity to identify any exceedance in threshold levels and associated observable biological effects to listed fish.

Based on the hydroacoustic assessment, and the minimization measures, temporary direct effects to listed fish are estimated from the **maximum** hydroacoustic impact (using highest sound pressure levels) as follows:

- any fish in the Acoustic Impact Area of 275 meters will be subject to direct effects, or cumulative SEL impacts, of between 183 and 187 dB.
- Fish within ten meters of pile driving may be exposed to peak sound levels of 206 dB.
- Fish within 1,970 meters would be exposed to RMS sound levels of 150 dB.

These direct effects from pile driving activity are anticipated to be temporary, and no ongoing or permanent adverse effects of the Action are anticipated.

Additional in-water work for the removal of existing piles, along with the deployment of spuds from the derrick barge, may contribute to increased water turbidity and mobilization of substrate. Elevated turbidity can impair gill function, reduce oxygen availability in the water column, decrease physiological capabilities, and increase stress in fish (Heath 1995). The increase in turbidity is anticipated to be localized and dissipate quickly due to tidal currents and river flow conditions. Project activities that may result in temporary increases in turbidity are likely to occur with other forms of disturbance or sound generation, such as the movement of tugs and cranes. These disturbances are likely to cause fish to move away from the areas where increases in turbidity would occur, prior to directly being exposed to the turbidity. **While turbidity can impact sensitive life stages of fish, elevated turbidity alone does not represent a uniform impact to protected fish species, as Delta smelt distribution has been correlated with turbidity which can help increase foraging efficiency and decrease predation threat (IEP 2015). Within the Delta, turbidity is generally between 20-40 nephelometric turbidity units (NTUs), and can increase to 250-500 NTUs during higher river flows (CDWR 2013). The actual distance suspended sediment caused by the Project would move is dependent upon multiple factors (i.e. tide, river flow, wind condition, etc.) and turbidity from pile removal and vibratory driving is anticipated to be confined within 45.7 m (150 ft) of the pile and would likely dissipate within five minutes (USFWS 2013). For much more sediment intensive activities, like clamshell dredging, turbidity generally extends a maximum of 304 m (1,000 ft) at the surface and 457 m (1,500 ft) near the substrate when using ineffective equipment (LTMS 2009). Any area of potential turbidity increase is well within the 1,970 m Action Area, and is anticipated to occur within less than 20% of the area identified with the 275 m Acoustic Impact Area (Figure 4). Turbidity may result in habitat, such as the shallow water habitat between the wharf and the shoreline, being temporarily unsuitable for fish. By restricting in-water work to the work window will reduce the potential for sensitive life stages of listed fish to occur and be affected by Project generated turbidity. Additionally, all water quality protection requirements identified by the Regional Water Quality Control Board (RWQCB) in the 401 certification for the Project will be followed.**

The suspension of sediment can also result in the release of contaminants into the water column, which can result in immediate or long term impacts for fish (LTMS 2009). In 2009 a vibracore sample analysis of sediment contamination in the vicinity of the GP wharf was investigated. **Benchmarks used as reference values for the test, as identified in the table**

in Appendix E, included San Francisco Bay Ambient Levels, Montezuma Wetlands Project (MWP) Sediment Acceptance Criteria⁷, CalEPA California Human Health Screening Levels (CHSSLs), U.S. EPA Preliminary Remediation Goals (PRGs), and San Francisco Bay RWQCB Environmental Screening Levels (ESLs)⁸. The MWP and ESLs test for environmental thresholds while CHSSLs, PRGs, and ESLs test for human thresholds. Results of the sediment testing (Appendix E) determined there were no constituents of concern above benchmark levels for toxicity (Weston 2010). Therefore, any mobilized sediment or increased turbidity caused by the Action are likely to only result in temporary affects to listed fish, and no ongoing or permanent adverse effects of the Action are anticipated.

There will be no vessel delivery of gypsum shipments during construction of the replacement Wharf, and therefore there will be no direct effect from noise, draft, or fugitive dust of gypsum shipment vessel traffic to listed fish.

Above-water work for the demolition and construction of the replacement portion of the Wharf will involve welding, drilling, and associated construction related activity, and is expected to contribute minimally to hydroacoustic direct effects. The sound produced by this activity is likely to be deadened as the sources will be out of the water, and is typical not a high pressure sound wave such as those produced by an impact hammer. To minimize potential adverse effects from demolition and construction, worker environmental training and BMPs including a debris containment boom and spill prevention kits will be used. Above-water work will be temporary, and is not anticipated to result in any adverse effects to listed fish.

5.1.2 Analysis of Direct Effects to LMB

Direct effects are those effects caused directly by the proposed Action that occur on-site within the Project Area and during Action implementation, i.e., ground disturbance within the Action Area.

Relatively little is currently known about acoustic impacts to terrestrial invertebrates (U.S. Department of Transportation 2004; Morley et al. 2014). Generally speaking, many

⁷ MWP: Criteria used by San Francisco RWQCB staff to determine if dredged material is suitable for reuse in beneficial environments, such as wetlands. Since 1992, testing of dredged materials for proposed beneficial reuse projects has followed recommendations in Regional Board Resolution No. 92-145, Sediment Screening Criteria and Testing Requirements for Wetland Creation and Upland Beneficial Reuse (SFBRWQCB, 1992). The recommended screening criteria in Resolution 92-145 were based on 1992 estimates of ambient chemical concentrations in sediments and soils, and on NOAA effects-based sediment concentrations of chemical constituents of concern.

⁸ ESLs: Under most circumstances, the presence of a chemical in soil, soil gas, or groundwater at concentrations below the corresponding ESL can be assumed to not pose a significant threat to human health, water resources, or the environment. ESLs address a greater range of media and endpoints than do other commonly-used screening levels, and reflect the broader scope of environmental concerns outlined in the San Francisco Bay (Region 2) Water Quality Control Plan (Basin Plan). Environmental concerns related to soil quality include direct exposure, leaching to groundwater, terrestrial receptors, and ceiling levels. Environmental concerns related to groundwater include drinking water, vapor intrusion, aquatic receptors, and ceiling levels.

invertebrates, including butterflies, are able to hear and communicate at frequencies below 10kHz and are able to hear within the main frequency spectrum of most anthropogenic noise and are thus likely to be impacted by it (Morley et al. 2014). Some research has been conducted regarding road noise on invertebrates. Grasshoppers and cicadas alter courtship frequencies and sound levels in response to noisy roads (Lampe et al. 2012; Shieh et al. 2012). According to the U.S. Department of Transportation, a few studies have indicated that several species are sensitive especially to low frequency vibration. Honeybees will stop moving for up to twenty minutes for sounds between 300 and 1 kHz at intensities between 107-120 dB (Frings and Little 1957). Frings and Frings (1959) reported that flies of the order *Diptera* showed a startle response at 80-800 Hz (at 80 dB) and at 120-250 Hz (from 3-18 dB above ambient levels). Most research is focused on how noise affects behavioral adaptations, and there is almost nothing in regard to how noise affects physiology such as development, neurobiology, genetics, or individual fitness (Morley et al. 2014).

For the Project, the main point of acoustic concern is due to impact pile driving. Conventional pile drivers are typically diesel powered; the impact of the hammer dropping onto the pile is the dominant noise component. Noise levels are difficult to measure or standardize, because they are affected by pile type and length, but peak levels in air tend to be about 100 dBA at 50 feet (USEPA 1971). In addition to the loudness of a noise produced, the noise impact severity of a particular source is also dependent on the temporal pattern of its emission. Pile driving would be required to install 13 piles for the replacement wharf, at an average of only 1-2 piles driven per day. As part of the project, pile driving will be conducted with both a vibratory hammer and a diesel impact hammer. It is estimated that each pile will require approximately 15 minutes of vibratory driving and 100 to 700 blows with an impact hammer to drive the piles to final tip elevation. Since noise levels from impact-hammer pile drivers are always higher than those from vibratory-hammer pile drivers, which are anticipated to be at or below ambient noise conditions, the Project construction noise impact discussion below considers only impact-hammer pile driver potential effects.

For the Project, the longest size pile that will be driven are the 72-inch piles at about 102 feet in length each. The mudline where the piles will be set is approximately -30 feet Mean Lower Low Water. Once the piles are upright, they will initially be driven with a vibratory hammer, which is anticipated to drive the pile 30 feet. An impact hammer will then be used to drive the remaining 37 feet of pile to design tip elevation. That will place the point of impact for the impact hammer, and point of sound production, approximately 42 feet above the water line. As the pile is driven, the point of impact will decrease in elevation above the water line until the final design elevation is met. During this process piles will become obscured from the Antioch Dunes National Wildlife Refuge once they fall below the existing height of riparian trees and vegetation lining the shoreline. Once the line-of-sight with the noise point source is broken, a sound reduction of 5 – 20 dBA (NoiseNet 2008) can be anticipated. The other sized pile are not as long as the 72-inch pile, and are anticipated to have less than 40 feet of pile above the water line that will be driven with an impact hammer, and would fall below the riparian vegetation line sooner.

In acoustics, because of the inverse-square law, the sound pressure of a spherical wavefront radiating from a point source decreases by 50% as the distance from the source is doubled (GSU 2015). This means that for every doubling of distance from the source, noise levels decrease by 6 dBA. The inverse-square law results in a rapid loss of sound intensity as the distance from the point source increases, as the energy twice as far from the source point is spread over four times the area. Therefore, if an unattenuated peak sound level is assumed at 100 dBA at 50 feet (point source measurement), then the noise levels at a distance of 100 feet

would be 6 dBA less than those at the point source (Caltrans 2013). As sound moves farther from the point source, unattenuated noise levels would be approximately 82 dBA at 400 feet and 76 dBA at 900 feet. Pre-project (background) ambient noise measurements taken within the Project site vicinity survey found daytime instantaneous noise levels there ranged from 50 dBA to 82 dBA². **Because sound levels from impact hammer driving are anticipated to be above ambient conditions, the Project incorporates minimization measures to prevent any potential acoustic disturbance to LMB.**

The Project will avoid impact pile driving during the LMB adult flight season, which ranges from August 1st to September 29th (Johnson et al. 2007, USFWS 2014, USFWS 2015). There are no thresholds or standards identified for acoustic impacts to LMB, and acoustic impacts are not identified as a threat to the species. There is no available science on what effect, if any, above ambient acoustic levels would have on the species life history or physiology. Despite this absence of data, the Project will avoid impact hammer driving during this period to prevent any potential adverse acoustic effects from the Project to adult breeding, feeding, or sheltering.

The proposed period when impact pile driving would occur for the Project is October 1st through November 30th. During this period, the only LMB life stage anticipated to occur within or adjacent to ADNWR would be eggs, which remain dormant until the rainy season (USFWS 2014). The adult flight season would be over, and larvae generally hatch out in February and the larvae reared in the captive breeding program are not released back to ADNWR until around late June (USFWS 2012a). Potential Project acoustic levels are not anticipated to affect eggs, as any wind and associated movement of the buckwheat would be much greater than the any potential minor vibrations in air pressure from sound resulting from impact hammer driving. Furthermore, any eggs present would be scattered around the host plants and would therefore receive additional acoustic sheltering from the physical structure of the plants. Thus, the project is not anticipated to directly affect eggs or larvae.

The Project has incorporated measures to protect LMB from potential acoustic effects of impact hammer driving. The Project will not result in the direct loss or modification of habitat for LMB, as all work occurs outside of LMB habitat.

There will be no vessel delivery of gypsum shipments during the replacement of the Wharf, and therefore there will be no direct effect to noise, draft, or fugitive dust of gypsum shipment vessel traffic to LMB.

The Project will not result in the direct loss or modification of habitat for LMB. Based on the minimization measures incorporated into the Project, adult LMB behavior during collection will not be affected, and the Project will have no effect on the timing, work, or access of staff conducting the collection. Furthermore, propagation and rearing occurs away from ADNWR, and release occurs in June, which is outside of the Project window, and will therefore not be affected. Based on the absence of habitat in the Project Area, there will be no direct effects on naked-stemmed buckwheat, LMB's host plant. The Project is not likely to adversely affect LMB, and will therefore have no effect on the catch and release propagation program.

5.1.3 *Analysis of Indirect Effects to Fish*

Indirect effects are those caused by or those that will result from the proposed Action later in time and outside the Project Area, but are still reasonably certain to occur. The Project will not result in a change in current terminal capacity or service as a result of the Action. Additional effects analysis of the vessels and gypsum shipment is provided as an interrelated effect. No indirect effects of the Action are anticipated for listed fish species.

5.1.4 *Analysis of Indirect Effects to LMB*

Indirect effects are those caused by or those that will result from the proposed Action later in time and outside the Project Area, but are still reasonably certain to occur. The Project will not result in a change in current terminal capacity or service as a result of the Action. **While potentially considered an indirect effect**, additional effects analysis of the vessels and gypsum shipment is provided as an interrelated effect. No indirect effects of the Action are anticipated for LMB.

5.1.5 *Analysis of Interrelated and Interdependent Effects to Fish*

Interrelated actions are those actions that are part of the primary action and dependent upon that primary action for their justification.

The Project will not result in a change in current terminal capacity or service as a result of the Action. There will be no change in the number of vessels or the number of or volume of gypsum shipments, and no change in Georgia-Pacific plant operation as a result of the Action (see Section 2.5). The increase in larger vessel traffic is limited to the size of the vessels that will arrive at the dock, not the number of vessels or volume of material being moved and thus will not result in any increase in fugitive dust, or other visual or underwater sound effects to fish. Additionally, the volume of gypsum shipments arriving at the Wharf will not change, and because the channel limits the draft for vessels, no increase in vessel draft is anticipated to occur as a result of the Action. There is also no planned dredging for the Wharf. Therefore, vessel traffic in the Project Area and downstream is expected to be unchanged as a result of the Action. While vessel traffic may also be considered an indirect or interdependent effect, it is considered as an interrelated effect with this analysis. Interrelated effects will not adversely affect listed fish species as a result of the Action.

Interdependent actions are those actions that have no independent utility apart from the primary action. Construction, maintenance, and use of a road required to access a site is an example of an interdependent effect. Increased boat traffic around the **Wharf** will result as part of the Action during construction. Work boats and material barges will be used to perform the Action. Effects from the use of work boats and material barges will last for the duration of the Action. Acoustic effects from the use of work boats and material barges are anticipated to be minimal, and are adequately captured in the Action Area as depicted. No interdependent effects are expected as a result of the Action because all construction and activities are considered under the primary Action.

5.1.6 Analysis of Interrelated and Interdependent Effects to LMB

Interrelated actions are those actions that are part of the primary action and dependent upon that primary action for their justification. The Project will not result in a change in current terminal capacity or service as a result of the Action. There will be no change in number of vessels or the number of or volume of gypsum shipments, and no change in Georgia-Pacific plant operation as a result of the Action (see Section 2.5). The increase in larger vessel traffic is limited to the size of the vessels that will arrive at the dock, not the number of vessels or volume of material being moved and thus will not result in any increase in fugitive dust, or noise effects to LMB. **There is no anticipated increase in fugitive dust anticipated during gypsum offloading. While the potential for increased gypsum delivery exists with larger vessels, the amount of gypsum the Georgia-Pacific plant can store, and would be offloaded at the Wharf, is limited by the size of the dome storage. There is no proposal at this time to change the dome storage capacity. A change in dome storage or creation of additional dome storage space would be permitted under a separate action. While gypsum dust has been identified as a potential threat to LMB eggs, larvae, and host plants, there is no evidence or research to support gypsum dust adversely affecting LMB or their host plant (USFWS 2008, Richmond et al. 2015). In addition to potential gypsum dust sources,** vessel traffic may also be considered an indirect or interdependent effect, it is considered as an interrelated effect with this analysis. Interrelated effects will not adversely affect LMB as a result of the Action.

Interdependent actions are those actions that have no independent utility apart from the primary action. Construction, maintenance, and use of a road required to access a site is an example of an interdependent effect. No interdependent effects are expected as a result of the Action because all construction and activities are considered under the primary Action.

5.1.7 Analysis of Cumulative Effects to Fish

Cumulative effects are those effects of future state or private activities, not involving federal activities, that are reasonably certain to occur within the action area of the federal action subject to consultation {50 CFR §402.02}. Future dredging or new dock projects would be considered cumulative effects. Furthermore, because no increase in the number of vessels visiting the dock is proposed, no cumulative effect from increased vessel traffic is anticipated. There are no currently proposed non-federal actions in the Action Area; therefore, no cumulative effects are anticipated to occur.

5.1.8 Analysis of Cumulative Effects to LMB

Cumulative effects are those effects of future state or private activities, not involving federal activities, that are reasonably certain to occur within the action area of the federal action subject to consultation {50 CFR §402.02}. **Nitrogen emission deposition from the nearby Oakley Generating has been identified as a threat by USFWS, and resulted in captive rearing of LMB and cultivation of their host and nectar plants for mitigation (USFWS 2010). Nitrogen fixation in the dunes, along with the captive rearing program and annual species surveys conducted by USFWS at ADNWR are cumulative impacts. Additionally in 2010, a safe harbor agreement between PG&E and the USFWS was completed for the area immediately west of the Sardis Unit which allowed continued service access for**

PG&E along the parcel⁹. Beneficial placement dredge sediment at ADNWR by the Port of Stockton was also authorized by USFWS in 2013¹⁰. While considered a benefit for the habitat, this activity is still considered a cumulative impact. Any increase in the frequency of trains or similar ambient noise level increases could also be considered a cumulative effect. No additional proposed non-federal actions in the Action Area are known at this time.

5.2 Analysis of Effects to Critical Habitat

The following section provides an analysis of potential effects from the proposed Action on critical habitat.

5.2.1 Analysis of Direct Effects

Direct effects are those effects caused directly by the proposed Action that occur on-site within the Project Area and during Action implementation, i.e., ground disturbance within the Action Area. The proposed Action will affect critical habitat for green sturgeon, Central Valley steelhead, and Delta smelt.

The proposed Action will require the removal of existing creosote treated pilings and the placement of steel monopoles. The new steel monopoles will result in a permanent impact of 34.63 square feet (0.0008 acres) to shallow water habitat (Table 7). This impact will not result in the loss or reduction in Primary Constituent Elements of critical habitat for green sturgeon, Central Valley steelhead, or Delta smelt; and will not result in impact to spawning habitat for these species.

Table 7. Permanent Impacts to Shallow Water Habitat

Pile Location	Square Feet	Acres
Mooring Dolphin 1	9.62	0.00022
Mooring Dolphin 2	9.62	0.00022
Mooring Dolphin 3	12.26	0.00029
Walkway Monopile (1x)	3.13	0.00007
Net Permanent Impact	34.63	0.00080

The Project will result in the removal of 150 14-inch diameter creosote treated timber piles and approximately 20 cubic yards less fill than the existing Wharf. Removal of the timber piles will benefit critical habitat for listed fish as removing these piles will reduce the amount of creosote potentially leaching into San Joaquin River and the downstream San Francisco Bay-Delta waters (Werme et al 2010). Additionally, the replacement Wharf will result in 157 square feet

⁹ ACOE communication dated May 29, 2015.

¹⁰ USFWS Reference Number 08ESMF00-2013-I-0500 dated July 3, 2013 and USFWS letter of concurrence dated July 10, 2013.

less over-water shadowing, and the new walkway will be made from a light transmitting material. Because of the reduction in fill, shading, and the removal of creosote treated piles, the Action will have a beneficial effect for critical habitat within the Action Area.

5.2.2 Analysis of Indirect Effects

Indirect effects are those caused by or those that will result from the proposed Action later in time and outside the Project Area, but are still reasonably certain to occur. The impact of sea-level rise over the functional lifespan of the Wharf has been evaluated with the Project design, and is not anticipated to affect the Wharf. Additionally, steel components within the splash zone of the Wharf will have coatings or galvanization to protect them from corrosion. Indirect effects will not adversely affect critical habitat as a result of the Action.

5.2.3 Analysis of Interrelated and Interdependent Effects

Interrelated actions are those actions that are part of the primary action and dependent upon that primary action for their justification. No other interrelated effects are expected as a result of the Action.

Interdependent actions are those actions that have no independent utility apart from the primary action. No interdependent effects are known for the Action Area.

5.2.4 Analysis of Cumulative Effects

Cumulative effects are those effects of future state or private activities, not involving federal activities, that are reasonably certain to occur within the action area of the federal action subject to consultation {50 CFR §402.02}. There are no currently proposed non-federal actions in the Action Area; therefore, no cumulative effects are anticipated to occur.

6.0 DETERMINATION OF EFFECT

The cumulative SEL arising from the construction aspects of the Action is anticipated to exceed the 183 and 187 dB criteria and as such could result in harm to fish species within the Project Area. Through careful analysis of the biological resources within the Project Area, the Applicant has developed avoidance and minimization measures for the Action that minimize impacts to federally-listed fish species within the Action Area. **These species include: Central Valley steelhead, Winter and Spring-run Chinook salmon, green sturgeon, delta smelt and longfin smelt.** Numerous protection measures have been incorporated into the proposed Project design. Thus, while the proposed Action may affect and is likely to adversely affect listed fish species in the Action Area, the implementation of the proposed measures described above will greatly minimize the potential impacts, including the potential for take occurring.

The Applicant has incorporated measure to protect LMB in the ADNWR from the Action. The Project will not result in the direct loss or modification of habitat for LMB, as all work occurs outside of LMB habitat. **Targeted protection measures, including restricted pile driving during the adult flight season have been incorporated into the proposed Project design to prevent potential effects to adult LMB.** There will be no effect of the Project on the captive

breeding program because adults will not be affected during collection, rearing occurs away from ADNWR, and release occurs outside of the Project window. In addition, while an increase in the size of vessel has already occurred, there will be no increase in the number of vessels or in the volume of materials being off-loaded at the dock, which will ensure no indirect or cumulative effects occur as the result of increased fugitive dust or noise from vessel traffic. **Adverse effects to adult LMB will be avoided by restricting impact hammer driving during the flight season, and will occur outside of the period larvae are present. The only life stage of LMB anticipated to occur within the Action Area during impact pile driving are eggs, which are not anticipated to be affected by sound or minor air pressure changes caused by sound (compared to natural wind conditions). Based on the avoidance measures provided in the Biological Assessment, the Project may affect, but is not likely to adversely affect LMB.**

The Project will result in the removal of creosote treated piles and a reduction in both fill and shading within the Project Area. The Action will result in improved aquatic habitat conditions within the Project Area. Furthermore, the Action is not likely to destroy or adversely modify critical habitat in the Action Area.

Due to several factors including a lack of suitable habitat within the Action Area, it was determined that the proposed project would not affect Callippe silverspot butterfly, Bay checkerspot butterfly, Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, valley elderberry longhorn beetle, vernal pool tadpole shrimp, tidewater goby, coho salmon, California tiger salamander, California red-legged frog, Alameda whipsnake, giant garter snake, Western snowy plover, California clapper rail, California least tern, San Joaquin kit fox, large-flowered fiddleneck, pallid manzanita, Contra Costa wallflower, Santa Cruz tarplant, Contra Costa goldfields or Antioch dunes evening primrose.

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APPENDIX A - Table of Federally-Listed Species for the Area

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SPECIES	STATUS*	HABITAT	POTENTIAL FOR OCCURRENCE
Mammals			
salt-marsh harvest mouse <i>Reithrodontomys raviventris</i>	FE	Primary habitat in pickleweed-dominated saline emergent marshes of San Francisco Bay. Do not burrow, build loosely organized nests. Require adjacent upland areas for escape from high tides.	Unlikely. The Project Area and adjacent areas do not contain salt marsh habitats to support this species. The nearest documented occurrence of this species is 2.5 miles west of the Project Area.
San Joaquin kit fox <i>Vulpes macrotis mutica</i>	FE	Found in annual grasslands or grassy open stages with scattered shrubby vegetation. Need loose-textured sandy soils for burrowing and suitable prey base.	Not Present. The Project Area does not contain open grassland habitats necessary for this species. All documented occurrences of this species within 5 miles of the Project Area were located due south in the Antioch hills. These hills are separated from the Project Area by extensive development, precluding this species' presence nearby.
Birds			
California brown pelican <i>Pelecanus occidentalis californicus</i>	FD	Winter/non-breeding visitor to estuarine and coastal marine waters. Nests in colonies on offshore islands, from the Channel Islands southward, that are free of mammalian predators and human disturbance. Individuals use breakwaters, jetties, sand bars, etc. for loafing and roosting.	Unlikely. This species does not nest in northern California. However, it may occasionally forage within the Project Area or use the pier for loafing.
California clapper rail <i>Rallus longirostris obsoletus</i>	FE	Found in tidal salt marshes of the San Francisco Bay. Require mudflats for foraging and dense vegetation on higher ground for nesting.	Not Present. Tidal salt marsh habitat is not present within the Project Area or adjacent Areas. The Project Area is located outside the known range of this species. The nearest documented occurrence of this species is over 11 miles west of the Project Area (CDFW 2014).

SPECIES	STATUS*	HABITAT	POTENTIAL FOR OCCURRENCE
western snowy plover <i>Charadrius alexandrinus nivosus</i>	FT	Found on sandy beaches, salt pond levees, and shores of large alkali lakes. Need sandy gravelly or friable soils for nesting.	Unlikely. Typical breeding and foraging habitat are not present in the Project Area or adjacent areas, and there are no documented occurrences of this species nearby (CDFW 2014).
California least tern <i>Sterna antillarum browni</i>	FE	Breeding colonies in San Francisco Bay found in abandoned salt ponds and along estuarine shores. Nests on barren to sparsely vegetated site near water.	Unlikely. Typical sparsely-vegetated breeding habitat is not present in the Project Area. This species may occasionally forage within the waters of the Project Area, but is unlikely to breed there. The nearest documented breeding occurrence for this species is over 7 miles west of the Project Area in Pittsburg (CDFW 2014)
Reptiles and Amphibians			
Alameda whipsnake <i>Masticophis lateralis euryxanthus</i>	FT	Prefers a chaparral habitat with rock outcroppings and small mammal burrows for basking and refuge. Can occur in adjacent communities, including grassland and oak savanna. Found in the east bay hills.	Not Present. Suitable chaparral habitat is not present in or near to the Project Area. Extensive development separates the Project Area from any suitable habitat for this species to the south in the Antioch hills.
California tiger salamander <i>Ambystoma californiense</i>	FT	Inhabits annual grass habitat and mammal burrows. Seasonal ponds and vernal pools crucial to breeding.	Not Present. Suitable aquatic and upland habitat is not present in the Project Area. The nearest documented occurrence of this species is 1.1 miles south of the Project Area (CDFW 2014). This occurrence is from 1983 and since then the area has been subject to extensive development and no wetland features with potential for breeding remain in the area. The species is considered extirpated from the area.

SPECIES	STATUS*	HABITAT	POTENTIAL FOR OCCURRENCE
California red-legged frog <i>Rana aurora draytonii</i>	FT	Associated with quiet perennial to intermittent ponds, stream pools, and wetlands. Prefers shorelines with extensive vegetation. Documented to disperse through upland habitats after rains.	Not Present. Suitable aquatic and upland habitat is not present in the Project Area. The nearest documented occurrence of this species is over 3.5 miles south of the Project Area, and is separated from the Project Area by extensive development (CDFW 2014).
giant garter snake <i>Thamnophis gigas</i>	FT	Inhabits agricultural wetlands and other waterways such as irrigation and drainage canals, sloughs, ponds, small lakes, low gradient streams, and adjacent uplands in the Central Valley. Habitat requirements consist of (1) adequate water from early-spring through mid-fall, (2) emergent, herbaceous wetland vegetation for escape cover and foraging habitat, 3) grassy banks and openings in waterside vegetation for basking, and (4) higher elevation uplands for cover and refuge from flood waters during the snake's dormant season in the winter.	Unlikely. This species has been documented 2.2 miles northeast of the Project Area across the San Joaquin River (CDFW 2014). The Project Area is along a deep (35 feet) portion of the San Joaquin River, and does not contain canals, sloughs, ponds or associated aquatic features used by the species. The closest occurrence of the species is within Sherman Island, which contains higher quality habitat that is much different than the industrial and urban development surrounded Project Area. Additionally the steep banks of the Project Area are armored with loose rock that is mostly unvegetated, further reducing the suitability of the Project Area for the species.
Fishes			
green sturgeon <i>Acipenser medirostris</i>	FT	Spawn in the Sacramento River and the Klamath River. Spawn in deep pools or "holes" in large, turbulent, freshwater river mainstems. Adults live in oceanic waters, bays, and estuaries when not spawning. Species is known to forage in estuaries and bays.	Present. This species is known to occur in the waters adjacent to the Project Area, and the Project Area is located within designated critical habitat for this species.

SPECIES	STATUS*	HABITAT	POTENTIAL FOR OCCURRENCE
coho salmon- central California coast ESU <i>Oncorhynchus kisutch</i>	FE, NMFS	Federal listing includes populations between Punta Gorda and San Lorenzo River. State listing includes populations south of San Francisco Bay only. Occurs inland and in coastal marine waters. Requires beds of loose, silt-free, coarse gravel for spawning. Also needs cover, cool water and sufficient dissolved oxygen.	Not Present. This species is considered extirpated from San Francisco Bay and San Joaquin River basin.
steelhead - central CA coast DPS <i>Oncorhynchus mykiss irideus</i>	FT, NMFS	Federal listing includes all runs from the Russian River south to Soquel Creek, inclusive. Includes the San Francisco and San Pablo Bay basins but excludes the Sacramento-San Joaquin River basins. Adults migrate upstream to spawn in cool, clear, well-oxygenated streams. Juveniles remain in fresh water for one or more years before migrating downstream to the ocean.	Unlikely. While this species is known to occur in the San Francisco Bay, the Project Area is located in the San-Joaquin River basin, outside of this ESU's range. Any steelhead found within the Project Area would be designated as Central Valley DPS fish.
steelhead - Central Valley DPS <i>Oncorhynchus mykiss irideus</i>	FT, NMFS	The Central Valley ESU includes all naturally-spawned populations (and their progeny) in the Sacramento and San Joaquin Rivers and their tributaries, excluding San Francisco and San Pablo bays and their tributaries.	Present. This species is known to occur in the waters adjacent to the Project Area, and the Project Area is located within designated critical habitat for this species.
Chinook Salmon - California coastal ESU <i>Oncorhynchus tshawytscha</i>	FT, NMFS	California Coastal Chinook Salmon ESU includes all naturally spawned populations of Chinook salmon from rivers and streams south of the Klamath River (exclusive) to the Russian River (inclusive). Adult numbers depend on pool depth and volume, amount of cover, and proximity to gravel. Water temps >27 degrees C lethal to adults.	Not Present. Project Area is outside of the known range for this species.

Chinook salmon - Central Valley spring-run ESU <i>Oncorhynchus tshawytscha</i>	FT, NMFS	Occurs in the Feather River and the Sacramento River and its tributaries, including Butte, Mill, Deer, Antelope and Beegum Creeks. Adults enter the Sacramento River from late March through September. Adults migrate upstream to spawn in cool, clear, well-oxygenated streams from mid-August through early October. Juveniles migrate soon after emergence as young-of-the-year, or remain in freshwater and migrate as yearlings.	Present. This species is known to occur in the waters adjacent to the Project Area, and the Project Area is located within designated critical habitat for this species.
Chinook salmon – Sacramento winter-run ESU <i>Oncorhynchus tshawytscha</i>	FE, NMFS	Prior to the construction of Shasta Dam, likely spawned in the headwaters of the Sacramento in streams fed mainly by the flow of constant-temperature springs. Currently spawn in the mainstem of the Sacramento from Redding downstream to Tehama. Adults migrate upstream to spawn in cool, clear, well-oxygenated streams.	Present. This species is known to occur in the waters adjacent to the Project Area.
Delta smelt <i>Hypomesus transpacificus</i>	FT	Lives in the Sacramento-San Joaquin estuary in areas where salt and freshwater systems meet. Occurs seasonally in Suisun Bay, Carquinez Strait and San Pablo Bay. Seldom found at salinities > 10 ppt; most often at salinities < 2 ppt.	Present. This species is known to occur in the waters adjacent to the Project Area, and has been documented within 5 miles of the Project Area (CDFW 2014).
longfin smelt <i>Spirinchus thaleichthys</i>	FC	Euryhaline, nektonic and anadromous. Found in open waters of estuaries, mostly in middle or bottom of water column. Prefer salinities of 15 to 30 ppt, but can be found in completely freshwater to almost pure seawater.	Present. This species is known to occur in the waters adjacent to the Project Area, and has been documented within 5 miles of the Project Area (CDFW 2014).
tidewater goby <i>Eucyclogobius newberryi</i>	FE	Found in the brackish waters of coastal lagoons, marshes, creeks, and estuaries. Unique among fishes of the Pacific coast, gobies are restricted to waters of low salinity in coastal wetlands. They feed along the bottom, preferring clean, shallow, slow-moving waters	Not Present. This species is not known to occur near the Project Area, and is considered extirpated from San Francisco Bay.

Invertebrates			
vernal pool fairy shrimp <i>Branchinecta lynchi</i>	FT	Inhabit small, clear-water sandstone-depression pools, grassy swales, slumps, or basalt-flow depression pools.	Not Present. No seasonal wetland habitat containing suitable hydrological conditions is located within the Project Area.
vernal pool tadpole shrimp <i>Lepidurus packardii</i>	FE	Pools commonly found in grass-bottomed swales of unplowed grasslands. Some pools are mud-bottomed and highly turbid.	Not Present. No vernal pool habitat containing suitable hydrological conditions is located in the Project Area.
conservancy fairy shrimp <i>Branchinecta conservatio</i>	FE	Inhabit rather large, cool-water vernal pools with moderately turbid water that generally last until June. Requires an average of 7 weeks of inundation to mature.	Not Present. No seasonal wetland habitat containing suitable hydrological conditions is located within the Project Area.
Lange's metalmark butterfly <i>Apodemia mormo langei</i>	FE	All the life stages of Lange's metalmark butterflies are found close to the larval food plant, buckwheat (<i>Eriogonum nudum</i> ssp. <i>auriculatum</i>). Adults may also use butterweed and snakeweed for nectar, as well as lupine for mating. Historically restricted to sand dunes along the southern bank of the Sacramento-San Joaquin River and currently found only at Antioch Sand Dunes in Contra Costa County.	Present. This species is known within the Antioch Dunes National Wildlife Refuge, within 0.25 miles from the pier. However, this species is unlikely to occur within the Project Area. The 2014 biological resource assessment pertaining to this project (Wood Biological Consulting 2014) found no host plants on the site; however, USFWS has mapped the host plant present (Appendix B – Supplemental Figure 2). Discussion of potential Project related acoustic effects and minimization measures are provided in the body of the Biological Assessment.
Plants			
large-flowered fiddleneck <i>Amsinckia grandiflora</i>	FE	Cismontane woodland, valley and foothill grassland. 275-305 m.	Not Present. No suitable habitat. The Project Area is in and adjacent to open water habitat. The Project Area does not contain cismontane woodland or valley and foothill grassland. In addition, the Project Area is below the elevation requirements of this species.

soft bird's beak <i>Cordylanthus mollis ssp. mollis</i>	FE	Coastal salt marshes. 0-3 m.	Not Present. Salt marsh habitat for this species is not present within or adjacent to the Project Area.
Contra Costa goldfields <i>Lasthenia conjugens</i>	FE	Cismontane woodland, playas (alkaline), valley and foothill grassland, vernal pools / mesic. 0-470 m.	Not Present. No suitable habitat for this species exists within the Project Area. The Project Area is in and adjacent to open water habitat. The Project Area does not contain cismontane woodland, alkaline playas, valley and foothill grassland, or vernal pools necessary for this species.
Contra Costa wallflower <i>Erysimum capitatum ssp. angustatum</i>	FE	Inland Dunes (known only from the Antioch Dunes in Contra Costa County). 3-20 m.	Unlikely. Marginally suitable dune habitat exists within the Project Area. A 2014 Biological Resource Assessment (Wood Biological Consulting 2014) did not document this species on the site and determined that a high level of surface disturbance likely precludes presence.
Antioch dunes evening primrose <i>Oenothera deltooides ssp. howellii</i>	FE	Endemic to California, and restricted to remnant river bluffs and inland dunes and found only in Contra Costa and Sacramento counties, from sea level to 30 m (0-100 ft).	Unlikely. Marginally suitable dune habitat exists within the Project Area. A 2014 Biological Resource Assessment (Wood Biological Consulting 2014) did not document this species on the site and determined that a high level of surface disturbance likely precludes presence.

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APPENDIX B – Figures

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Figure 1. Project Location Map

Georgia-Pacific Antioch Wharf
Breasting Dolphins Replacement
Contra Costa County, California



0 0.75 1.5
Miles

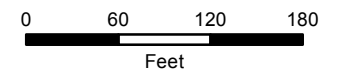
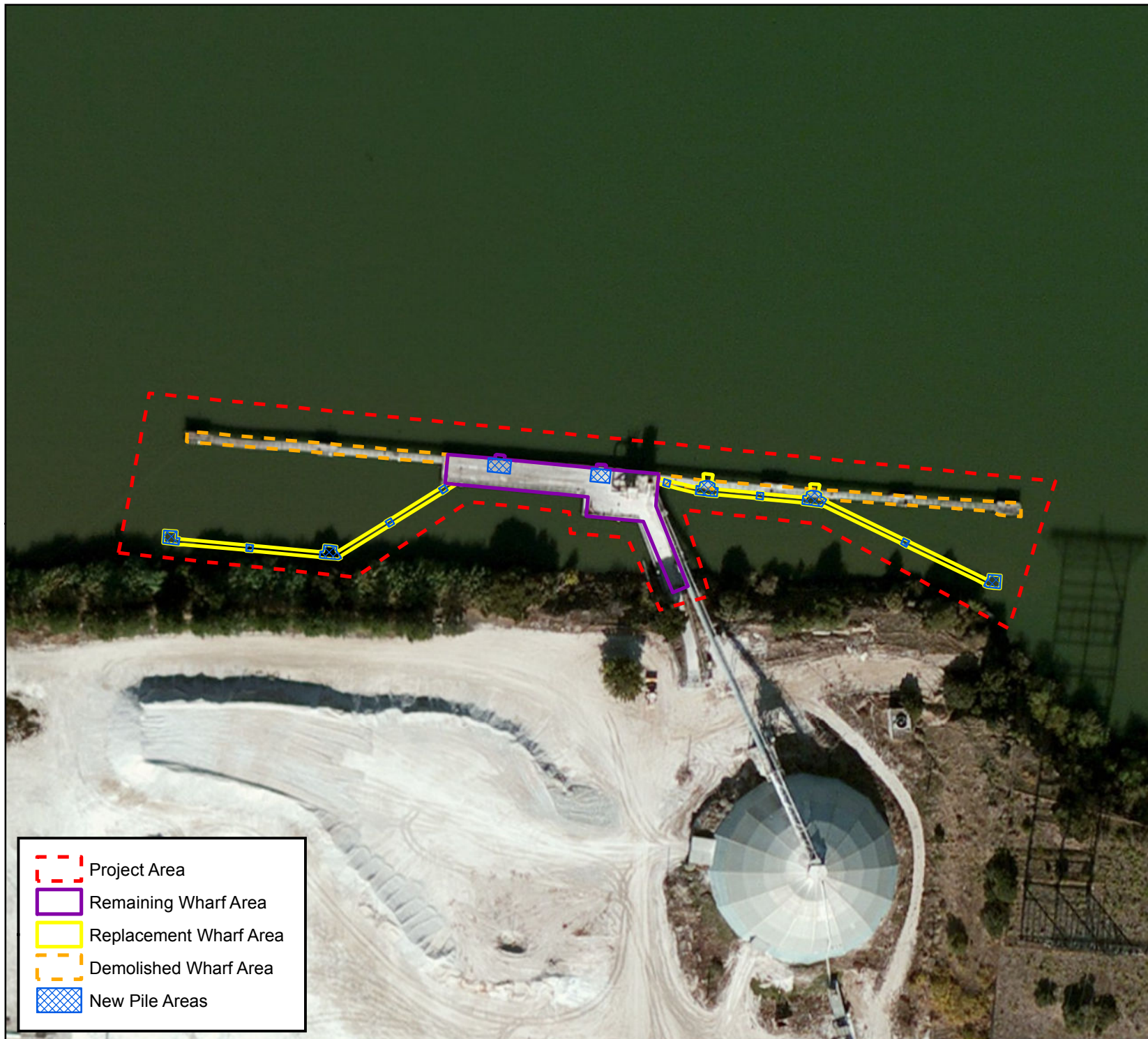


Map Date: December 2014
Map By: Chris Zumwalt
Base Source: ESRI World Topo

Georgia-Pacific
Antioch Wharf
Breasting Dolphins
Replacement Project

Contra Costa County,
CA

Figure 2
Wharf Project Area
Overview



Map Date: December 2014
Map By: Chris Zumwalt
Base Source: ESRI Streaming 11/2/2010

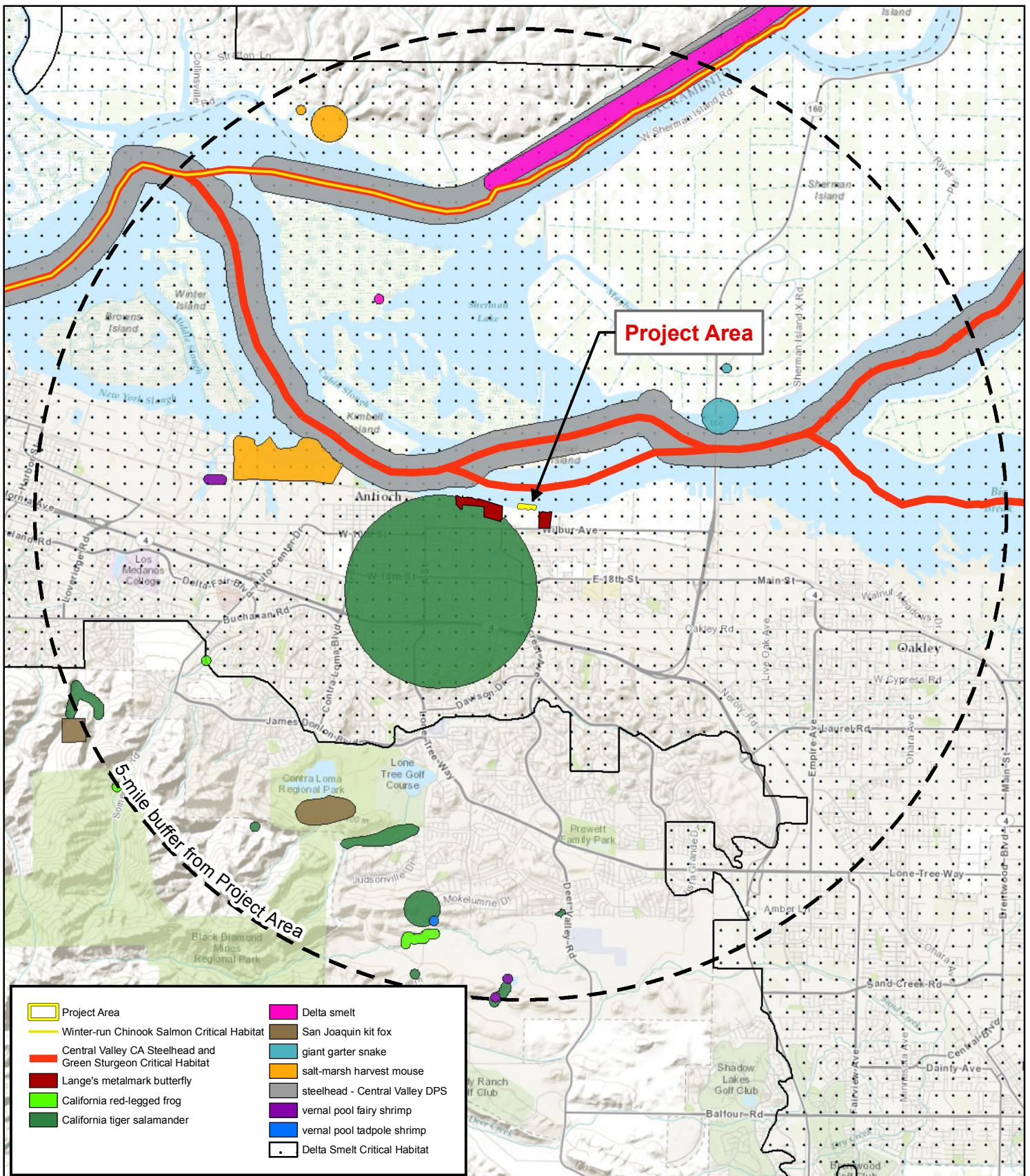


Figure 3. CNDDDB Wildlife Occurrences and Critical Habitats

Georgia-Pacific Antioch Wharf Breasting Dolphins Replacement Project
Contra Costa County, CA



0 0.5 1 1.5
Miles



Date: December 2014
Map By: Chris Zumwalt
Base Source: USGS Topo

Georgia-Pacific
Antioch Wharf
Breasting Dolphins
Replacement Project

Contra Costa County,
CA

Figure 4
Hydroacoustic
Action Area



0 900 1,800 2,700
Feet

Map Date: December 2014
Map By: Chris Zumwalt
Base Source: ESRI Streaming 11/02/2010

Georgia-Pacific
Antioch Wharf
Breasting Dolphins
Replacement Project

Contra Costa County,
CA

Figure 5
Wharf Project Area
Details



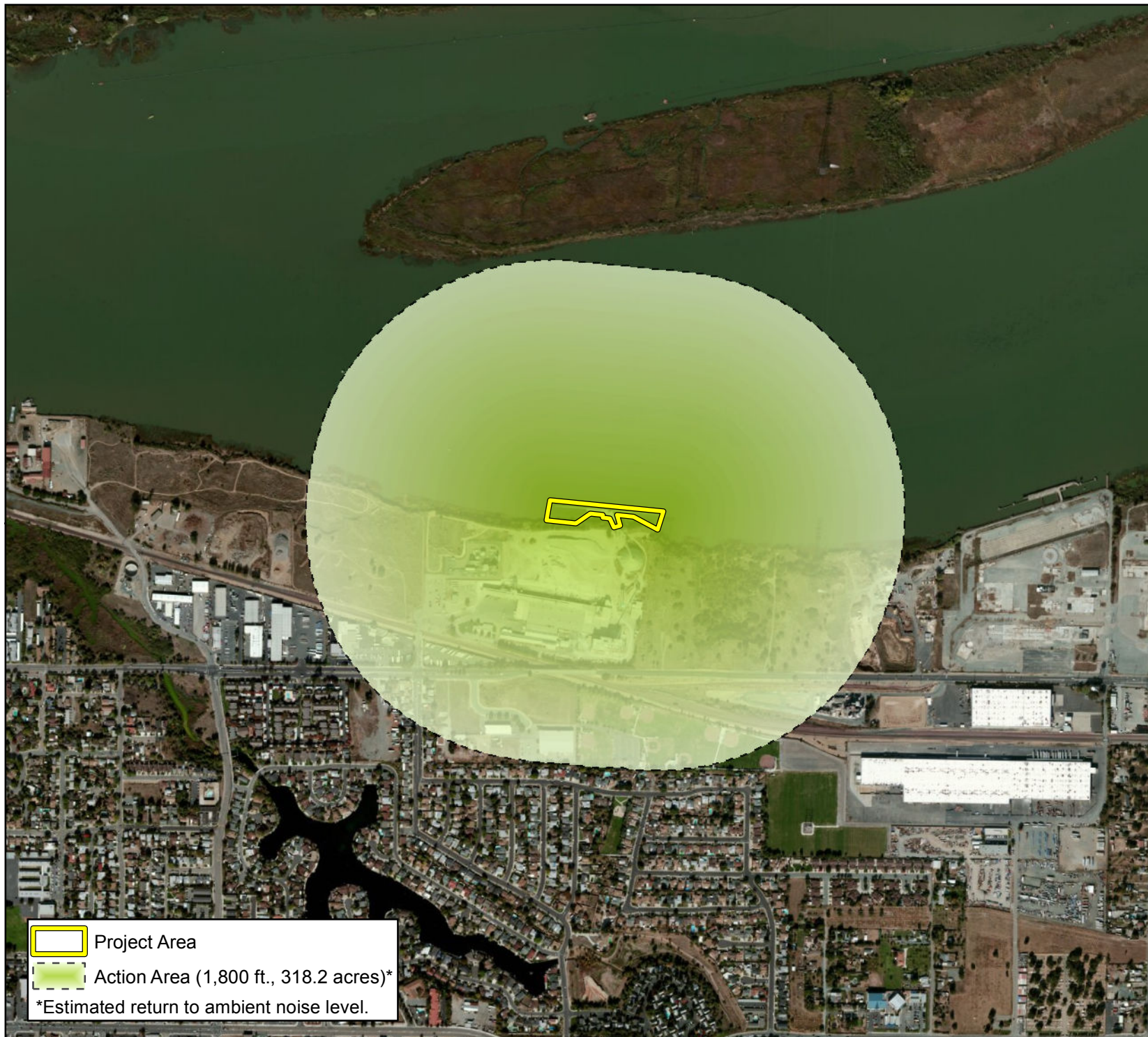
0 50 100 150
Feet

Map Date: December 2014
Map By: Chris Zumwalt
Base Source: ESRI Streaming 11/2/2010

Georgia-Pacific
Antioch Wharf
Breasting Dolphins
Replacement Project

Contra Costa County,
CA

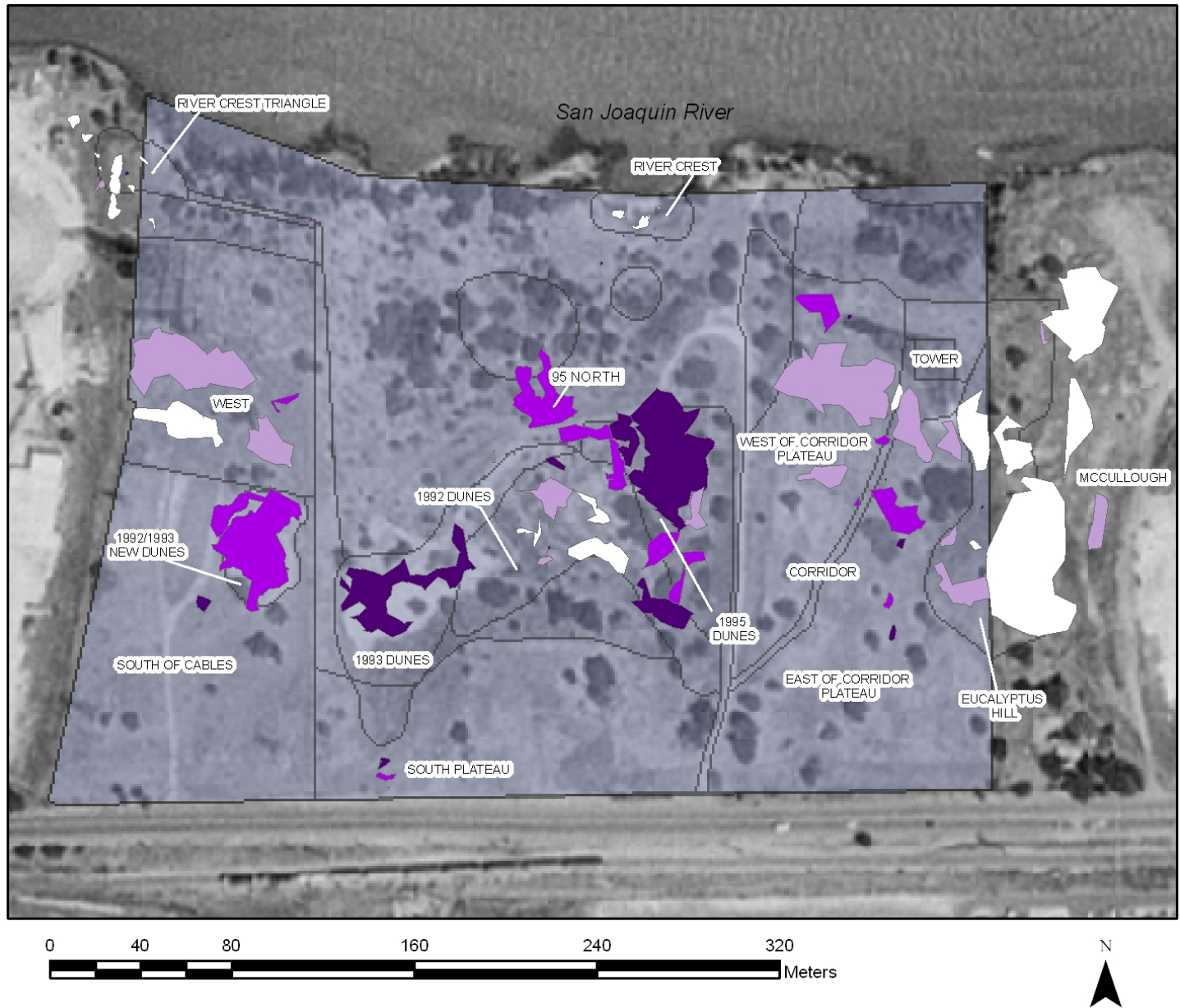
Supplemental Figure 1.
USFWS Acoustic
Action Area



0 500 1,000 1,500
Feet

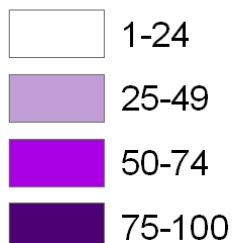
Map Date: April 2015
Map By: Chris Zumwalt
Base Source: ESRI Streaming 11/02/2010

Sardis Buckwheat Density 2005-2006



Supplemental Figure 2. Buckwheat Density in Sardis Unit

Buckwheat Percent Cover



U.S. Fish and Wildlife Service

Antioch Dunes National Wildlife Refuge

P.O. Box 524
Newark, CA 94560

510-521-9624
www.fws.gov/sfbayrefuges/



March, 2006

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APPENDIX C - Unattenuated Aquatic Action Area

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The following figures and table are intended to supplement the Biological Assessment (WRA 2015) for the Georgia-Pacific Antioch Wharf Project. This information was requested by the US Army Corps of Engineers to assist with the consultation process with National Marine Fisheries Service (NMFS) and the US Fish and Wildlife Service (USFWS).

NMFS Hydroacoustic Action Area

Supplemental Figure 1. NMFS Hydroacoustic Action Area. This figure depicts the anticipated distance the 150 dB threshold (Action Area) and the cumulative SEL of 187 dB threshold (Acoustic Impact Area) will extend from impact pile driving locations when sound attenuation methods are used. The 187 dB threshold is intended for fish >2 grams. The area (acres) each threshold is anticipated to extend is provided in the table below.

Supplemental Table 1. Area and radius for hydroacoustic effects identified in Supplemental Figure 1.

Area	Acreage	Square Feet	Radius (meters)*	Description
Action Area	776.82	33,838,223	1,970	The anticipated maximum distance for 150 dB using attenuation; discussed in greater detail and shown on Fig 4 of the Biological Assessment (BA).
Acoustic Impact Area	22.07	961,412	160	The anticipated maximum distance for cumulative SEL of 187 dB using attenuation; discussed in greater detail in the BA and shown on Supplemental Figure 1.
10m Buffer From Pile Driving Locations	1.18	51,448	10	The anticipated maximum distance for 206 dB using attenuation; 10m buffer applied around each pile driving location.




Georgia-Pacific
Antioch Wharf
Breasting Dolphins
Replacement Project

Contra Costa County,
CA

Supplemental Figure 1.

NMFS Hydroacoustic
Action Area



-  Project Area
 -  Acoustic Impact Area* (160 meters)
 -  Action Area (1,970 meters)
- *Cumulative SEL of 187dB



0 300 600 900
Meters

Map Date: February 2014
Map By: Chris Zumwalt
Base Source: ESRI Streaming 11/02/2010

Hydroacoustic Impact Areas Without Sound Attenuation

The following information is intended to provide the anticipated area for the hydroacoustic thresholds when no sound attenuation is used. Two figures are provided which illustrate the increased area impacted when pile driving is unattenuated. The project design incorporates multiple approaches to attenuate potentially harmful hydroacoustic levels and minimize the impact to listed fish. These measures are provided in detail in the BA.

NMFS Unattenuated Hydroacoustic Action Area

Supplemental Figure 2. NMFS Unattenuated Hydroacoustic Action Area. This figure depicts the anticipated distance the 150 dB threshold (Action Area) and the cumulative SEL of 187 dB threshold (Acoustic Impact Area) will extend from impact pile driving locations when no sound attenuation is used. The 187 db threshold is intended for fish >2 grams. The area (acres) each threshold is anticipated to extend is provided in the table below. As described in the BA, river bathymetry and island/terrestrial land masses are anticipated to distort and limit the extent of the Action Area.

Supplemental Table 2. Area and radius for unattenuated hydroacoustic effects identified in Supplemental Figure 2.

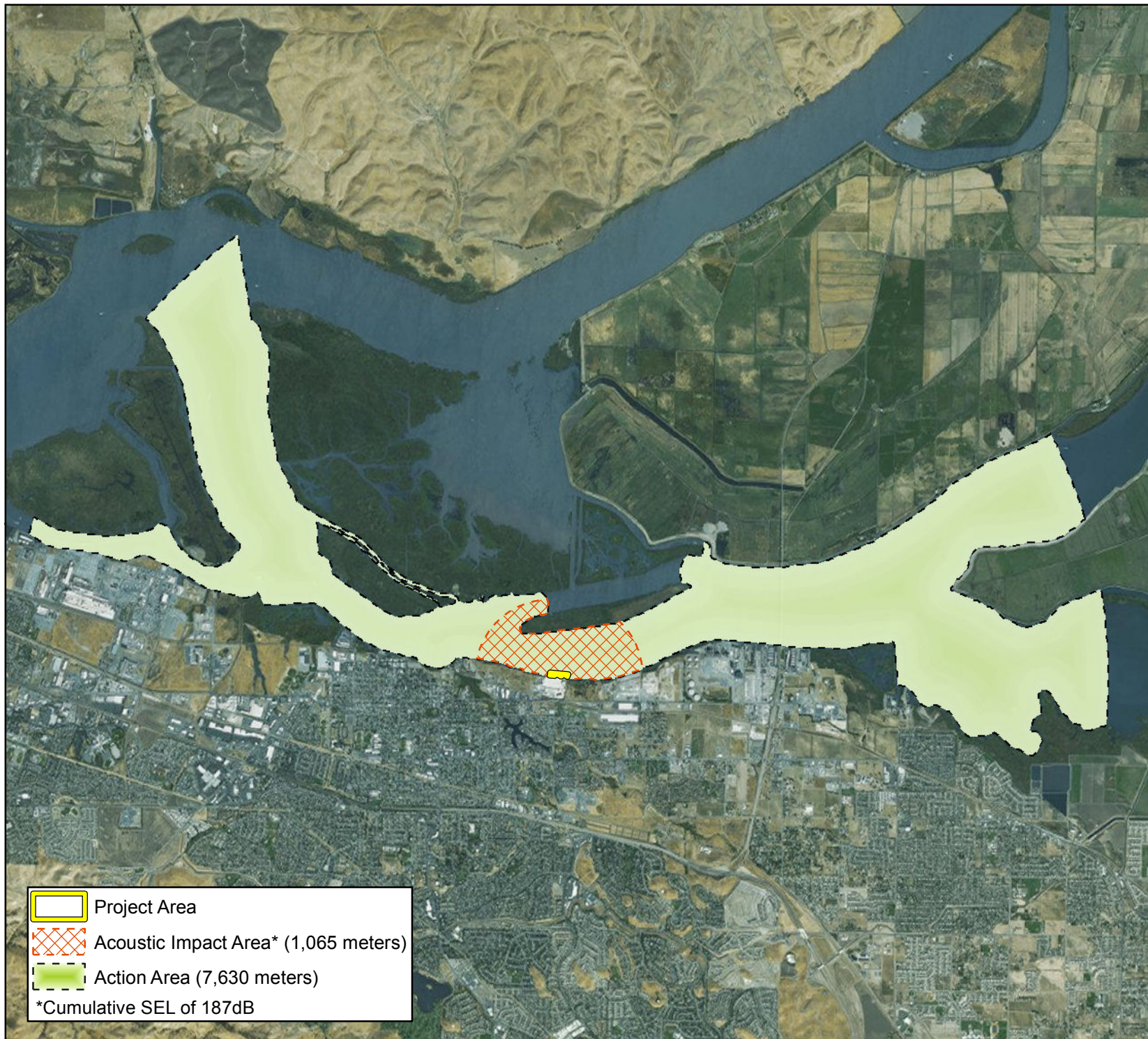
Area	Acreage	Square Feet	Radius (meters)*	Description
Action Area	5,6163.82	244,667,785	7,630	The anticipated maximum distance for 150 dB using attenuation; discussed in greater detail and shown on Fig 4 of the Biological Assessment (BA).
Acoustic Impact Area	184.67	8,044,131	620	The anticipated maximum distance for cumulative SEL of 187 dB using attenuation; discussed in greater detail in the BA and shown on Supplemental Figure 2.
30m Buffer From Pile Driving Locations	3.48	151,804	30	The anticipated maximum distance for 206 dB using attenuation; 30m buffer applied around each pile driving location.




Georgia-Pacific
Antioch Wharf
Breasting Dolphins
Replacement Project

Contra Costa County,
CA

Supplemental Figure 2.

NMFS Unattenuated
Hydroacoustic
Action Area



-  Project Area
 -  Acoustic Impact Area* (1,065 meters)
 -  Action Area (7,630 meters)
- *Cumulative SEL of 187dB



0 900 1,800 2,700
Meters

Map Date: February 2014
Map By: Chris Zumwalt
Base Source: ESRI Streaming 11/02/2010

USFWS Unattenuated Hydroacoustic Action Area

Supplemental Figure 3. USFWS Unattenuated Hydroacoustic Action Area. This figure depicts the anticipated distance the 150 dB threshold (Action Area) and the cumulative SEL of 183 dB threshold (Acoustic Impact Area) will extend from impact pile driving locations when no sound attenuation is used. The 183 dB threshold is intended for fish <2 grams. The area (acres) each threshold is anticipated to extend is provided in the table below. As described in the BA, river bathymetry and island/terrestrial land masses are anticipated to distort and limit the extent of the Action Area.

Supplemental Table 3. Area and radius for unattenuated hydroacoustic effects identified in Supplemental Figure 3.

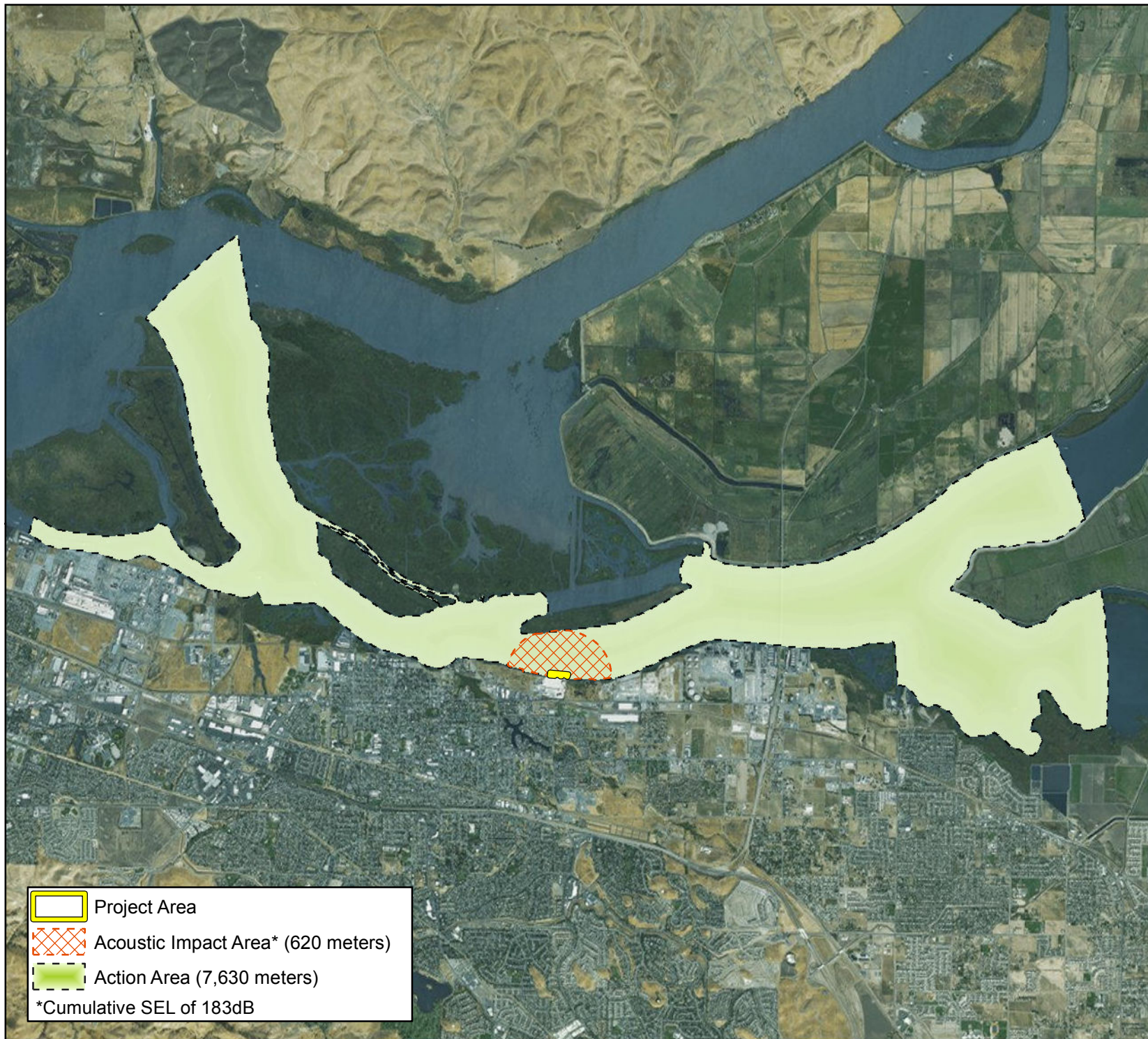
Area	Acreage	Square Feet	Radius (meters)*	Description
Action Area	5,6163.82	244,667,785	7,630	The anticipated maximum distance for 150 dB using attenuation; discussed in greater detail and shown on Fig 4 of the Biological Assessment (BA).
Acoustic Impact Area	377.20	16,430,953	1,065	The anticipated maximum distance for cumulative SEL of 183 dB using attenuation; discussed in greater detail in the BA and shown on Supplemental Figure 3.
30m Buffer From Pile Driving Locations	3.48	151,804	30	The anticipated maximum distance for 206 dB using attenuation; 30m buffer applied around each pile driving location.




Georgia-Pacific
Antioch Wharf
Breasting Dolphins
Replacement Project

Contra Costa County,
CA

Supplemental Figure 3.

USFWS
Unattenuated
Hydroacoustic Action
Area



-  Project Area
 -  Acoustic Impact Area* (620 meters)
 -  Action Area (7,630 meters)
- *Cumulative SEL of 183dB



0 900 1,800 2,700
Meters

Map Date: February 2014
Map By: Chris Zumwalt
Base Source: ESRI Streaming 11/02/2010

APPENDIX D – Hydroacoustic Assessment

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Georgia-Pacific Antioch Terminal Breasting Dolphin Replacement Project

UNDERWATER NOISE ASSESSMENT

Draft November 2014

Final January 2015



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Project No: 14-191

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I. INTRODUCTION

Georgia-Pacific proposes to drive thirteen (13) piles in the San Joaquin River to replace a portion of their terminal in Antioch, CA. This report is an assessment of potential sound levels generated by planned pile driving activities for the Georgia-Pacific Antioch Terminal Breasting Dolphin Replacement Project. The project proposes to install three (3) 24-inch steel pipe piles, three (3) 30-inch steel pipe piles, two (2) 42-inch steel pipe piles, one (1) 48-inch steel pipe pile, and four (4) 72-inch steel pipe piles as part of the new structure.

Pile driving will be conducted with both a vibratory hammer and a diesel impact hammer. It is estimated that each pile will require approximately 15 minutes of vibratory driving and 100 to 700 blows with an impact hammer to drive the piles to final tip elevation.

This report includes the prediction of underwater sound levels. Calculations are based on the results of measurements for similar projects. Predicted underwater sound levels are compared against interim thresholds that have been accepted by the Federal Highway Administration (FHWA), California Department of Transportation (Caltrans), and the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS). These thresholds are discussed in this report.

Pile driving will produce underwater noise in and around the project area. Most of the pile driving activities would be in water about 30 feet deep, and would be in the vicinity of the existing docks. It is difficult to predict underwater sound levels from pile driving activities without actual measurements of similar piles in the area. However, it is possible to estimate the sound level based on the results of measurements that have been previously performed for similar projects in different areas. In this analysis, available underwater sound data for projects involving the installation of similar types of piles were reviewed. The sound levels for proposed pile driving activities were estimated using these data combined with an understanding of how and where these activities would occur. These predictions are essentially a best estimate based on empirical data and engineering judgment, but by their very nature contain a degree of uncertainty. The duration of driving for each pile installation and number of piles strikes were also estimated as part of the noise prediction process, based on available data from similar projects and engineering estimates.

II. UNDERWATER SOUNDS FROM PILE DRIVING

Fundamentals of Underwater Noise

Sound is typically described by the pitch and loudness. Pitch is the height or depth of a tone or sound, depending on the relative rapidity (frequency) of the vibrations by which it is produced. Loudness is intensity of sound waves combined with the reception characteristics of the auditory system. Intensity may be compared with the height of an ocean wave in that it is a measure of the amplitude of the sound wave.

In addition to the concepts of pitch and loudness, there are several noise measurement scales which are used to describe sound. A decibel (dB) is a unit of measurement describing the amplitude of

sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. For underwater sounds, a reference pressure of 1 micropascal (μPa) is commonly used to describe sounds in terms of decibels. Therefore, 0 dB on the decibel scale would be a measure of sound pressure of 1 μPa . Sound levels in decibels are calculated on a logarithmic basis. An increase of 10 decibels represents a ten-fold increase in acoustic energy, while 20 decibels is 100 times more intense, 30 decibels is 1,000 times more intense, etc.

When a pile driving hammer strikes a pile a pulse is created that propagates through the pile and radiates sound into the water, the ground substrate, and the air. Sound pressure pulse as a function of time is referred to as the waveform. In terms of acoustics, these sounds are described by the peak pressure, the root-mean-square pressure (RMS), and the sound exposure level (SEL). The peak pressure is the highest absolute value of the measured waveform, and can be a negative or positive pressure peak. For pile driving pulses, RMS level is determined by analyzing the waveform and computing the average of the squared pressures over the time that comprise that portion of the waveform containing the vast majority of the sound energy.¹ The pulse RMS has been approximated in the field for pile driving sounds by measuring the signal with a precision sound level meter set to the “impulse” RMS setting and is typically used to assess impacts to marine mammals. Another measure of the pressure waveform that can be used to describe the pulse is the sound energy itself. The total sound energy in the pulse is referred to in many ways, such as the “total energy flux”.² The “total energy flux” is equivalent to the unweighted SEL for a plane wave propagating in a free field, a common unit of sound energy used in airborne acoustics to describe short-duration events referred to as dB re: $1\mu\text{Pa}^2\text{-sec}$. Peak pressures and RMS sound pressure levels are expressed in dB re: $1\mu\text{Pa}$. The total sound energy in an impulse accumulates over the duration of that pulse. Figure 1 illustrates the descriptors used to describe the acoustical characteristics of an underwater pile driving pulse. Table 1 includes the definitions of terms commonly used to describe underwater sounds.

The variation of instantaneous pressure over the duration of a sound event is referred to as the waveform. Studying the waveforms can provide an indication of rise time; however, rise time differences are not clearly apparent for pile driving sounds due to the numerous rapid fluctuations that are characteristic to this type of impulse. A plot showing the accumulation of sound energy over the duration of the pulse (or at least the portion where much of the energy accumulates) illustrates the differences in source strength and rise time. An example of the characteristics of a typical pile driving pulse is shown in Figure 1.

¹ Richardson, Greene, Malone & Thomson, *Marine Mammals and Noise*, Academic Press, 1995 and Greene, personal communication.

² Finerann, et. al., *Temporary Shift in Masked Hearing Thresholds in Odontocetes after Exposure to Single Underwater Impulses from a Seismic Watergun*, Journal of the Acoustical Society of America, June 2002.

Table 1 - Definitions of Underwater Acoustical Terms

Term	Definition
Decibel, dB	A unit describing, the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. The reference pressure for air is 20 micropascals (μPa) and 1 μPa for underwater.
Equivalent Noise Level, L_{eq}	The average noise level during the measurement period.
L_{01} , L_{10} , L_{50} , L_{90}	The sound levels that are exceeded 1%, 10%, 50%, and 90% of the time during the measurement period.
Peak Sound Pressure, unweighted (dB)	Peak sound pressure level based on the largest absolute value of the instantaneous sound pressure. This pressure is expressed in this report as a decibel (referenced to a pressure of 1 μPa) but can also be expressed in units of pressure, such as μPa or PSI.
RMS Sound Pressure Level, (NMFS Criterion)	The average of the squared pressures over the time that comprise that portion of the waveform containing 90 percent of the sound energy for one pile driving impulse. ³
Sound Exposure Level (SEL), dB re: 1 μPa ² sec	Proportionally equivalent to the time integral of the pressure squared and is described in this report in terms of dB re: 1 μPa ² sec over the duration of the impulse. Similar to the unweighted Sound Exposure Level (SEL) standardized in airborne acoustics to study noise from single events.
Cumulative SEL	Measure of the total energy received through a pile-driving event (here defined as pile driving over one day)
Waveforms, μPa over time	A graphical plot illustrating the time history of positive and negative sound pressure of individual pile strikes shown as a plot of μPa over time (i.e., seconds)
Frequency Spectra, dB over frequency range	A graphical plot illustrating the distribution of sound pressure vs. frequency for a waveform, dimension in RMS pressure and defined frequency bandwidth

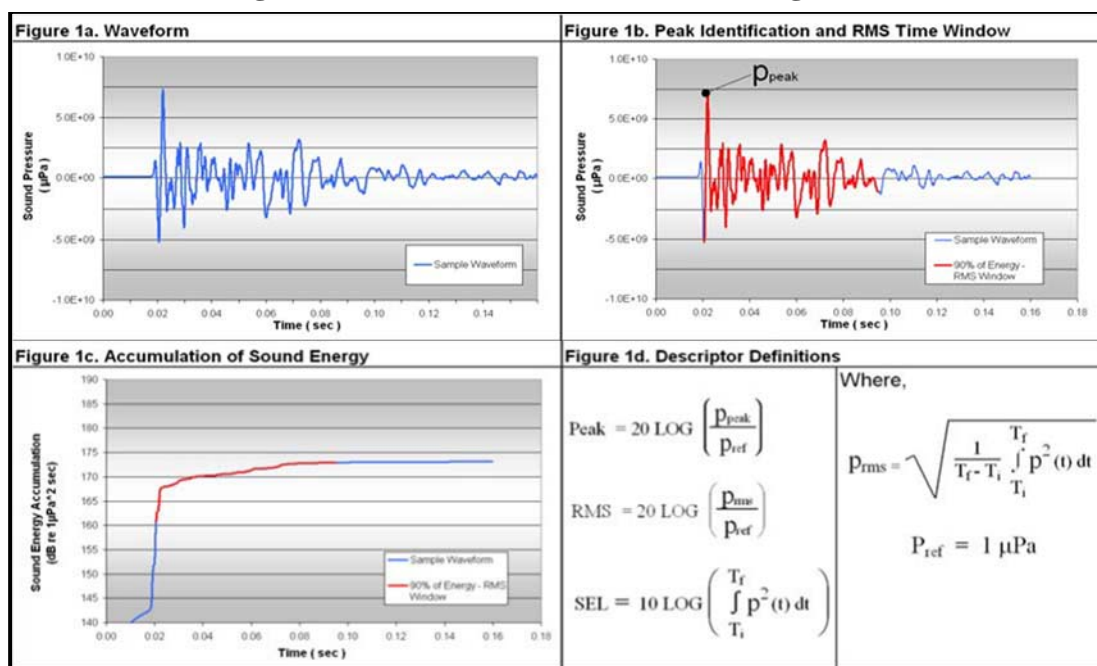
SEL is an acoustic metric that provides an indication of the amount of acoustical energy contained in a sound event. For pile driving, the typical event can be one pile driving pulse or many pulses such as pile driving for one pile or for one day of driving multiple piles. Typically, SEL is measured for a single strike and a cumulative condition. The cumulative SEL associated with the driving of a pile can be estimated using the single strike SEL value and the number of pile strikes through the following equation:

$$SEL_{CUMULATIVE} = SEL_{SINGLE\ STRIKE} + 10 \log (\# \text{ of pile strikes})$$

For example, if a single strike SEL for a pile is 165 dB and it takes 1,000 strikes to drive the pile, the cumulative SEL is 195 dBA (165 dB + 30 dB = 195 dB), where $10 * \log(1000) = 30$.

³ The underwater sound measurement results obtained during the Pile Installation Demonstration Project indicated that most pile driving impulses occurred over a 50 to 100 millisecond (msec) period. Most of the energy was contained in the first 30 to 50 msec. Analysis of that underwater acoustic data for various pile strikes at various distances demonstrated that the acoustic signal measured using the standard “impulse exponential-time-weighting” (35-msec rise time) correlated to the RMS (impulse) level measured over the duration of the impulse.

Figure 1 - Characteristics of a Pile Driving Pulse



III. UNDERWATER SOUND THRESHOLDS

Underwater sound effects to fish and marine mammals are discussed below. In this report, peak pressures and RMS sound pressure levels are expressed in decibels re: $1 \mu\text{Pa}$. Sound exposure levels are expressed as dB re: $1 \mu\text{Pa}^2 \cdot \text{sec}$.

Fish

A Fisheries Hydroacoustic Workgroup (FHWG) that consisted of transportation officials, resources agencies, the marine construction industry (including Ports), and other experts was formed in 2003 to address the underwater sound issues associated with marine construction. The first order of business was to document all that was clearly known about the effects of sound on fish, which was reported in "The Effects of Sound on Fish."⁴ This report recommended preliminary guidance to protect fish. A graph showing the relationship between the SEL from a single pile strike and injurious effects to fish based on size (i.e., mass) was presented. Fish with a mass of about 0.03 grams were expected to have no injury for a received SEL of a pile strike below 194 dB and suffer 50% mortality at about 197 dB. The report also described possible effects to the auditory system (i.e., auditory tissue damage and hearing loss), based on a received dose of sound. The recommendations were frequency dependent, based on the hearing thresholds of fish or most sensitive auditory bandwidths. For salmonids, hearing effects would be expected at or near the thresholds for injury based on the single strike SEL. A further investigation into the effects of pile

⁴ Hastings, M and A. Popper. 2005. The Effects of Sound on Fish. Prepared for the California Department of Transportation. January 28 (revised August 23).

driving sounds on fish was also recommended.

Caltrans commissioned a subsequent report to provide additional explanation of, and a practical means to apply, injury criteria recommended in “The Effects of Sound on Fish.” This report is entitled “Interim Criteria for Injury of Fish Exposed to Pile Driving Operations: A White Paper,” (White Paper).⁵ The White Paper recommended a dual criterion for evaluating the potential for injury to fish from pile driving operations. The dual approach considered that a single pile strike with high enough amplitude, as measured by zero to peak (either negative or positive pressure) could cause injury. A peak pressure threshold for a single strike was recommended at 208 dB. In 2007, Carlson et al provided an update to the White Paper in a memo titled “Update on Recommendation for Revised Interim Sound Exposure Criteria for Fish during Pile Driving Activities.”⁶ In this memo, they propose criteria for each of three different effects on fish: 1) hearing loss due to temporary threshold shift, 2) damage to auditory tissues, and 3) damage to non-auditory tissues. These criteria vary due to the mass of the fish and if the fish is a hearing specialist or hearing generalist. In preparing this update, Dr. Mardi Hastings summarized information from some current studies in a report titled “Calculation of SEL for Govoni et al. (2003, 2007) and Popper et al. (2007) Studies.”

On June 12, 2008, NMFS; U.S. Fish and Wildlife Service (USFWS); California, Oregon, and Washington Departments of Transportation; California Department of Fish and Game; and the U.S. Federal Highway Administration generally agreed in principal to interim criteria to protect fish from pile driving activities, as shown in Table 2. Note that the peak pressure criterion of 206 dB was adopted (rather than 208 dB), as well as accumulated SEL criteria for fish smaller than 2 grams. NMFS interpretation of the interim criteria is described by Woodbury and Stadler (2009).⁷

Table 2 - Adopted Impact Pile Driving Acoustic Criteria for Fish

Interim Criteria for Injury	Agreement in Principle
Peak	206 dB for all sizes of fish
Cumulative SEL	187 dB for fish size of two grams or greater. 183 dB for fish size of less than two grams.
Behavior effects threshold for all sizes of fish is 150 dB RMS	

The primary difference between the adopted criteria and previous recommendations is that the single strike SEL was replaced with a cumulative SEL over a day of pile driving. NMFS does not consider sound that produces an SEL per strike of less than 150 dB to accumulate and cause injury.

⁵ Popper, A., Carlson, T., Hawkins, A., Southall, B. and Gentry, R. 2006. Interim Criteria for Injury of Fish Exposed to Pile Driving Operations: A White Paper. May 14.

⁶ Carlson, T, Hastings, M and Popper, A. 2007. Memo to Suzanne Theiss, California Department of Transportation, Subject: Update on Recommendations for Revised Interim Sound Exposure Criteria for Fish during Pile Driving Activities. December 21.

⁷ Stadler, J. and Woodbury, D. 2009. Assessing the effects to fishes from pile driving: Application of new hydroacoustic criteria. Proceedings of inter-noise 2009, Ottawa, Canada. August 23-26.

The adopted criteria listed in Table 2 are for pulse-type sounds (e.g., pile driving) and does not address sound from vibratory driving of piles; there are no acoustic thresholds that apply to the lower amplitude noise produced by vibratory pile driving. In fact, the acoustic thresholds developed for fish only apply to impact pile driving.

The Bureau of Ocean Energy Management, (BOEM—formerly Minerals Management Service), Caltrans, and National Cooperation of Highway Research Programs (NCHRP 25–28)/Transportation Research Board (TRB) have funded studies to identify the onset of injury to fish from impact pile driving. One of the goals of these studies was to provide quantitative data to define the levels of impulsive sound that could result in the onset of barotrauma injury to fish.⁸ Laboratory simulation of pulse-type pile driving sounds enabled careful study of the barotrauma effects to Chinook salmon. The neutrally buoyant juvenile fish were exposed to impulsive sounds and subsequently evaluated for barotrauma injuries. Significant barotrauma injuries were not observed in fish exposed to 960 pulses at 180 dB SEL per pulse or 1,920 pulses at 177 dB per pulse. In both exposures, the resulting accumulated SEL was 210 dB SEL. Results of these studies are under review. At this time, the criteria in Table 2 are used by NMFS to judge impacts to fish. Potential behavior impacts that might occur above 150 dB RMS are not used to restrict pile driving.

IV. UNDERWATER SOUND GENERATING ACTIVITIES

Project Related Noise Sources

The primary sound generating activities associated with this project would be vibratory driving followed by impact driving of the steel shell piles. Preliminary indications are that an APE 400 vibratory hammer and a Delmag D160 diesel impact hammer would be required to drive the 42-inch, 48-inch, and the 72-inch piles. The 24-inch and the 30-inch walkway piles will be installed using an ICE 44 vibratory hammer and a Delmag D62 diesel impact hammer. The driving periods are not likely to be continuous. The required pile embedment and estimated number of pile strikes per pile is shown in Table 3.

⁸ Halvorsen MB, Casper BM, Woodley CM, Carlson TJ, Popper AN (2012) Threshold for Onset of Injury in Chinook Salmon from Exposure to Impulsive Pile Driving Sounds. PLoS ONE 7(6): e38968. doi:10.1371/journal.pone.0038968

Table 3 - Piles Associated with New Terminal Construction Activities

Location	Quantity	Diameter (inches)	Pile Embedment Depth (feet)	Estimated Number of Pile Strikes
Breasting Dolphin Piles	4	72	65	700
Mooring Piles	2	42	51	420
	1	48	56	520
Walkway Piles	1	24	38	160
	2	24	48	360
	3	30	35	100

For vibratory installation it is estimated that the piles will be driven 30 feet; which would take approximately 15 minutes for each pile. For impact pile driving, pile installation is estimated to require 20 blows per foot until the pile reaches its required depth. A full pile driving event was assumed to require 100 to 700 pile strikes. The project would install one (1) pile per day for the 72-inch piles and up to two (2) piles per day for all other piles. In terms of underwater sound effects on fish, the highest cumulative sound levels would occur under any scenario where a 72-inch pile is impact driven in one day.

Impact pile driving produces pulsed-type sounds, while vibratory driving will produce more continuous-type sounds. The distinction between these two general sound types is important because they have differing potential to cause physical effects, particularly with regard to hearing. Pulsed sounds, such as impact pile driving, explosions, or seismic air guns, are brief, distinct acoustic events that occur either as an isolated event (e.g., explosion) or repeated in some succession (e.g., impact pile driving). Pulsed sounds are all characterized by discrete acoustic events that include a relatively rapid rise in pressure from ambient conditions to a maximum pressure value followed by a decay period that may include a period of diminishing, oscillating maximal and minimal pressures. Pulsed sounds are typically high amplitude events that have the potential to cause hearing injury. Continuous or non-pulsed sounds can be tonal or broadband. These sounds include vessels, aircraft, machinery operations such as vibratory pile driving or drilling, and active sonar systems. This project will have both pulsed and continuous type sounds from pile installation.

Discussion of Underwater Sound Generation from Pile Driving

A review of underwater sound measurements for similar projects was undertaken to estimate the near-source sound levels for vibratory and impact pile driving. Sounds from similar-sized steel shell piles have been measured in water for several projects. Measurements conducted for the Richmond Inner Harbor Project, Richmond San Rafael Bridge Seismic Retrofit, Trinidad Pier Replacement, Amorco Wharf Construction Project, the US Navy Test Pile Program and the US Navy Explosive Handling Wharf Project (EHW) are most representative due to the similar pile size and depth of water at the site. The projects included installation of 24-inch, 36-inch, 48-inch, and

72-inch diameter steel pipe piles. It is estimated that the noise levels for the 30-inch piles will be similar to the 36-inch piles and 42-inch piles will be the same as the 48-inch piles. Table 4 shows the acoustical measurements that were made during the installation of these piles.^{9,10,11,12,13}

Table 4 - Underwater Sound Levels at 10 Meters Based on Similar Projects

Pile Driving Scenario	Peak Pressure (dB re:1μPa)	RMS Sound Pressure Level (dB re:1μPa)	SEL (dB re: 1μPa²sec)	Data Source
24-in. Diameter Impact Pile Driving	205	189	178	Amorco Wharf Construction
30-in. Diameter Impact Pile Driving (similar to 36 in)	208	190	177	U.S. Navy Kitsap Bangor
42 & 48-in. Diameter Impact Pile Driving	209	192	180	U.S. Navy Kitsap Bangor
72-in. Diameter Impact Pile Driving	214	199	189	Richmond San Rafael Bridge

Prediction of Underwater Sound from Project Pile Driving

Estimated noise impacts are discussed specifically for each type of pile driving. The near source sound levels were used to predict underwater sound levels at various distances from the pile being driven. These levels represent unattenuated conditions (i.e., no air bubble curtain or other means of reducing underwater sound levels). Based on past projects it is estimated that sound levels can be reduced up to 10 dB using a properly deployed attenuation device.

Sound from pile installation (i.e., impact driving) would transmit or propagate from the construction area. Transmission loss (TL) is the decrease in acoustic pressure as the sound pressure wave propagates away from the source. TL parameters vary with frequency, temperature, sea conditions, current, source and receiver depth, water depth, water chemistry, and bottom composition and topography. NMFS has developed an underwater acoustic calculator that uses practical spreading to predict sound levels at various distances from the source. The formula for transmission loss is $TL = X \log_{10} (R/10)$, where X is the calculated drop off rate and R is the distance from the source assuming the near source levels are at 10 meters. This TL model, based on the default practical spreading loss assumption, was used to predict underwater sound levels generated by pile installation from this project. For this analysis a TL of 18 to 20 Log(R/10) (i.e.,

⁹ Illingworth & Rodkin. 2012. Naval Base Kitsap at Bangor Test Pile Program: Acoustic Monitoring Report. Prepared by Illingworth & Rodkin, Inc. for U.S. Navy.

¹⁰ Illingworth & Rodkin, Inc. 2013. Naval Base Kitsap at Bangor Trident Support Facilities Explosive Handling Wharf (EHW-2) Project - Acoustic Monitoring Report, BANGOR, WASHINGTON. 23 April 2013, Revised 15 May 2013. Prepared by Illingworth & Rodkin, Inc. for U.S. Navy. Available at http://www.nmfs.noaa.gov/pr/pdfs/permits/navy_kitsap_ehw2_acoustics2013.pdf, accessed October 15, 2014.

¹¹ Illingworth & Rodkin. 2009. Trinidad Pier Replacement. Prepared by Illingworth & Rodkin, Inc.

¹² Illingworth & Rodkin. 2003. Letter to Michael Cheney reporting results of underwater sound measurements. Prepared by Illingworth & Rodkin, Inc. for Castrol Oil.

¹³ Illingworth & Rodkin. 2005. Letter to Sharon Lim (Tesoro) reporting results of underwater sound measurements. Prepared by Illingworth & Rodkin, Inc. for Tesoro.

18 dB loss per ten-fold increase in distance) was used for vibratory pile driving and a 17 Log TL(R/10) function was used for impact driving. These TL values were measured based on the drop off rate for EHW measurements in relatively deep water across the Hood Canal. This rate of transmission loss was much less than that measured by Blackwell in the Knik Arm of 22 to 29 dB per 10-fold increase in distance.¹⁴ However, NMFS recommends a default practical spreading loss of 15 dB per ten-fold increase in distance when reliable data not available. Measurements conducted during pile driving for the project could further refine the rate of sound propagation or TL.

Impact Pile Driving

Peak sound pressure levels, average RMS sound pressure levels, and SELs from impact driving were predicted using the near source levels for impact pile driving and the practical loss sound propagation assumptions described above. Table 5 shows the extent of sound levels for the NMFS marine mammal and fish criteria.

Reducing sounds from impact pile driving using air bubble curtains is common. Caltrans reports a large range in sound reduction from almost no reduction to 30 dB as a result of use of these curtains. During the EHW project (i.e., the source of impact pile driving levels for this assessment) the reduction from an air bubble curtain was between 8 and 14 dB. Therefore, this assessment assumes that underwater sounds could be reduced at least 10 dB with the use of a properly designed and deployed air bubble curtain attenuation system.

Accumulated SEL levels associated with impact pile driving will vary daily, depending on the amount of pile driving. Table 6 shows the estimated accumulated SEL levels at 10 meters and the estimated distances to the accumulated 187 dB and 183 dB SEL level with and without an attenuation system. Reduction in the SEL level requires a properly designed and deployed air bubble curtain system.

¹⁴ Blackwell, S.B., 2005. Underwater Sound Measurements of Pile-Driving Sounds during the Port MacKenzie Dock Modifications, 13-16 August 2004. Greeneridge Sciences Report 328-1.March 2005.

Table 5 - Modeled Extent of Sound Pressure Levels from Unattenuated and Attenuated Impact Driving of One Pile

Modeling Scenario	Distance to Marine Mammal Acoustic Criteria in Meters			Distance to Fish Acoustic Criteria in Meters			Distance to Behavioral Zone
	RMS (dB re: 1uPa)			Peak (dB re: 1uPa)	Cumulative SEL ¹⁵ (dB re:1uPa-sec2)		RMS (db re:1uPa)
	Level B Harassment	Level A Injury					
	160	180	190	206	187	183	150
72-inch Piles (Pile ID: BD 1-4) Estimated 700 Pile Strikes per Pile							
Modeled Unattenuated	1,970 ¹⁶	130	35	30	620	1,065 ¹⁶	7,630 ¹⁶
Assuming a 10 dB Reduction with Attenuation	510	35	<10	<10	160	275	1,970 ¹⁶
48-inch Pile (Pile ID: MD 3) Estimated 520 Pile Strikes							
Modeled Unattenuated	765 ¹⁶	50	15	15	155	265	2,955 ¹⁶
Assuming a 10 dB Reduction with Attenuation	200	15	<10	<10	40	70	765 ¹⁶
42-inch Piles (Pile ID: MD 1&2) Estimated 420 Pile Strikes per Pile							
Modeled Unattenuated	765 ¹⁶	50	15	15	135	235	2,955 ¹⁶
Assuming a 10 dB Reduction with Attenuation	200	15	<10	<10	35	60	765 ¹⁶
30-inch Piles (Pile ID: WB 3-5) Estimated 100 Pile Strikes per Pile							
Modeled Unattenuated	580	40	<10	15	40	70	2,255 ¹⁶
Assuming a 10 dB Reduction with Attenuation	150	<10	<10	<10	10	20	580
24-inch Piles (Pile ID: WB 2&6) Estimated 360 Pile Strikes per Pile							
Modeled Unattenuated	510	35	<10	<10	95	160	1,970 ¹⁶
Assuming a 10 dB Reduction with Attenuation	130	<10	<10	<10	25	40	510
24-inch Pile (Pile ID: WB 1) Estimated 160 Pile Strikes							
Modeled Unattenuated	510	35	<10	<10	60	100	1,970 ¹⁶
Assuming a 10 dB Reduction with Attenuation	130	<10	<10	<10	15	25	510

¹⁵ Base on the driving of one pile. SEL criteria apply to impact pile driving events that occur during one day. See Table 6 for predicted accumulated SEL for various daily pile driving scenarios.

¹⁶ Distance to underwater noise thresholds is partially constrained by river topography

Table 6 - Cumulative SEL levels at 10 meters and Distances to the 187 dB and 183 dB Cumulative SEL Criterion for Pile Driving

Modeling Scenario	Total Strikes	Attenuation	Cumulative SEL (dB) at 10 Meters	Distance to 187 dB Cumulative SEL (Meters)	Distance to 183 dB Cumulative SEL (Meters)
One 72-inch pile	700	Unattenuated	217	62016	1065 ¹⁷
		Attenuated	207	160	275
MD1 (42-inch) & WB1 (24-inch)	580	Unattenuated	207	145	245
		Attenuated	197	40	65
MD2 (42-inch) & WB2 (24-inch)	780	Unattenuated	208	170	290
		Attenuated	198	45	75
BD1 (72-inch) & WB3 (30-inch)	800	Unattenuated	217	585	1005 ¹⁷
		Attenuated	207	150	260
WB4 (30-inch) & WB5 (30-inch)	200	Unattenuated	200	60	100
		Attenuated	190	15	25
WB6 (24-inch) & MD3 (48-inch)	880	Unattenuated	209	180	315
		Attenuated	198	50	80
WB5 (30-inch) & WB6 (24-inch)	460	Unattenuated	204	95	165
		Attenuated	194	25	40

¹⁷ Distance to underwater noise thresholds is partially constrained by river topography

V. CONCLUSION

The levels generated during impact driving of all unattenuated piles except the 24-inch piles will exceed the adopted 206 dB peak criteria for injury to fish. The levels generated during impact pile driving of all attenuated piles will not exceed the 206 dB peak criteria. The cumulative SEL will exceed the 187 dB criteria with and without an attenuation system on all piles.

The worst case scenario for impact driving is driving a single 72-inch pile. It is estimated that the 206 dB peak level for an unattenuated 72-inch pile is at 30 meters. The cumulative SEL will exceed the 187 dB criteria out to a distance of approximately 620 meters unattenuated and 160 meters attenuated.

Vibratory pile installation results in much lower amplitude sound levels. The use of vibratory hammers for pile driving in San Francisco Bay is allowed without restrictions on the size of piles or time of year work is performed according to the program level “Not Likely to Adversely

Affect” (NLAA) consultation from the U.S. Army Corps of Engineers (Corps) in 2006. The NLAA consultation was developed jointly between the Corps, USFWS, and NMFS, and was approved by the USFWS on December 6, 2006, and by NMFS on December 21, 2007. The NLAA consultation concluded that use of a vibratory hammer, regardless of pile size, is not likely to exceed underwater sounds level thresholds established by NMFS for impacts to fish. While the application of the NLAA consultation to actions undertaken by non-governmental entities is up to the discretion of the Corps and NMFS, the measures included in that consultation are useful as guidance, and the Action’s use of a vibratory hammer is consistent with the NLAA standards.

APPENDIX E – Sediment Toxicity Results

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Table D-1. Results of Chemical and Physical Analyses of Georgia Pacific Surface Sediments (Weston, 2010)

Analyte		GP-COMP Results	Reference Values								
			SF Bay Ambient Levels ^a	MWP Acceptance Criteria ^b		CalEPA CHSSL ^c		U.S. EPA PRGs ^d		SF Bay RWQCB ESLs ^e	
				Non Cover	Cover	Residential	Industrial/ Commercial	Residential	Industrial/ Commercial	Residential	Industrial/ Commercial
Conventionals											
Grain Size (%)	Gravel	2.41	-	-	-	-	-	-	-	-	-
	Sand	85.0	-	-	-	-	-	-	-	-	-
	Silt	7.32	-	-	-	-	-	-	-	-	-
	Clay	5.34	-	-	-	-	-	-	-	-	-
Total Solids (%)		78.5	-	-	-	-	-	-	-	-	-
Metals (mg/kg)											
Arsenic		5.00	15.3	85	33	0.070	0.2	0.39	1.6	0.39	1.6
Cadmium		0.192	0.33	9	0.5	1.7	7.5	70	800	1.7	7.4
Chromium		23.4	112	300	220	17	37	280	1,400	NA	NA
Copper		16.1	68.1	390	90	3,000	38,000	3,100	41,000	230	230
Lead		10.5	43.2	110	50	150	3,500	400	800	200	750
Mercury		0.109	0.43	1.3	0.35	18	180	4.3	24	1.3	10
Nickel		39.2	112	200	140	1,600	16,000	1,500	20,000	150	150
Selenium		0.145	0.64	1.4	0.7	380	4,800	390	5,100	10	10
Silver		0.140	0.58	2.2	1.0	380	4,800	390	5,100	20	40
Zinc		53.5	158	270	160	23,000	100,000	23,000	310,000	600	600
PAHs (µg/kg)											
Acenaphthene		10.7	26.6	NA	NA	NA	NA	3,400,000	33,000,000	19,000	19,000
Acenaphthylene		< 5.96	31.7	NA	NA	NA	NA	NA	NA	NA	NA
Anthracene		16.2	88	NA	NA	NA	NA	17,000,000	170,000,000	2,800	2,800
Benzo (a) anthracene		148	244	NA	NA	NA	NA	150	2,100	380	1,300
Benzo (b) fluoranthene		181	371	NA	NA	NA	NA	150	2,100	380	1,300
Benzo (k) fluoranthene		86.7	258	NA	NA	NA	NA	1,500	21,000	380	1,300
Benzo (ghi) perylene		< 12.4	310	NA	NA	NA	NA	NA	NA	27,000	27,000
Benzo (a) pyrene		49.7	412	NA	NA	38	130	15	210	38	130
Chrysene		188	289	NA	NA	NA	NA	15,000	21,000	23,000	23,000
Dibenz (a,h) anthracene		19.1	32.7	NA	NA	NA	NA	15	210	62	210
Fluoranthene		547	514	NA	NA	NA	NA	2,300,000	22,000,000	40,000	40,000
Fluorene		15.8	25.3	NA	NA	NA	NA	2,300,000	22,000,000	8,900	8,900
Indeno (1,2,3-cd) pyrene		34.9	382	NA	NA	NA	NA	150	2,100	620	2,100
Naphthalene		3.24	55.8	NA	NA	NA	NA	3,900	20,000	1,300	2,800
Phenanthrene		303	237	NA	NA	NA	NA	NA	NA	11,000	11,000
Pyrene		227	665	NA	NA	NA	NA	1,700,000	17,000,000	85,000	85,000
TOTAL PAHs		1,830	3,390	35,000	4,000	NA	NA	NA	NA	NA	NA

NA Not Available, < Indicates concentrations are less than the corresponding method detection limit (MDL),

^a Ambient Levels reported for fine grained sediment (SFBRWQCB 1998)

^b Montezuma Wetlands Project WDR Sediment Acceptance Criteria (SFBRWQCB 1999)

^c California Human Health Screening Levels (CHHSLs) (OEHHA 2009)

^d Preliminary Remediation Goals (PRGs) U.S. EPA Region 9 (USEPA 2009)

^e Environmental Screening Levels (ESLs) for sites where groundwater is not drinking water source (SFBRWQCB 2008)

Table D-1 Continued. Results of Chemical and Physical Analyses of Georgia Pacific Surface Sediments (Weston 2010)

Analyte	GP-COMP Results	Reference Values								
		SF Bay Ambient Levels ^a	MWP Acceptance Criteria ^b		CalEPA CHSSL ^c		U.S. EPA PRGs ^d		SF Bay RWQCB ESLs ^e	
			Non Cover	Cover	Residential	Industrial/ Commercial	Residential	Industrial/ Commercial	Residential	Industrial/ Commercial
Organotins (µg/kg)										
Tetrabutyltin	<1.13	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tributyltin	< 1.26	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibutyltin	< 1.47	NA	NA	NA	NA	NA	NA	NA	NA	NA
Monobutyltin	<0.70	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor PCBs (µg/kg)										
1016	< 2.98	NA	NA	NA	NA	NA	3,900	21,000	NA	NA
1221	< 2.98	NA	NA	NA	NA	NA	170	620	NA	NA
1232	< 2.98	NA	NA	NA	NA	NA	170	620	NA	NA
1242	< 2.98	NA	NA	NA	NA	NA	220	740	NA	NA
1248	< 2.98	NA	NA	NA	NA	NA	220	740	NA	NA
1254	< 2.98	NA	NA	NA	NA	NA	220	740	NA	NA
1260	< 2.98	NA	NA	NA	NA	NA	220	740	NA	NA
Total	< 2.98	30	400	50	178	600	NA	NA	440	1,480
Pesticides (µg/kg)										
Aldrin	< 0.32	NA	NA	NA	33	130	29	100	32	130
Alpha-BHC	< 0.17	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beta-BHC	< 0.27	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gamma-BHC	< 0.22	NA	NA	NA	NA	NA	NA	NA	NA	NA
Delta-BHC	< 0.26	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chlordane (Total)	< 3.03	1.1	1.1	1.1	430	1,700	1,600	6,500	440	1,700
2,4-DDD	< 0.78	NA	NA	NA	NA	NA	NA	NA	NA	NA
4,4-DDD	< 0.31	NA	NA	NA	2,300	9,000	2,000	7,200	2,300	9,000
2,4 DDE	< 0.69	NA	NA	NA	NA	NA	NA	NA	NA	NA
4,4 DDE	< 0.30	NA	NA	NA	1,600	6,300	1,400	5,100	1,600	4,000
2,4 DDT	< 1.27	NA	NA	NA	NA	NA	NA	NA	NA	NA
4,4 DDT	< 0.20	NA	NA	NA	1,600	6,300	1,700	7,000	1,600	4,000
Total DDT	< 0.20	7	100	3	NA	NA	NA	NA	NA	NA
Dieldrin	< 0.30	0.44	0.44	0.44	35	130	30	110	2.3	2.3
Endosulfan I	< 0.27	NA	NA	NA	NA	NA	370,000	3,700,000	4.6	4.6
Endosulfan II	< 0.48	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endosulfan sulfate	< 0.31	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endrin	< 0.31	NA	NA	NA	21,000	230,000	18,000	180,000	0.65	0.65
Endrin aldehyde	< 0.19	NA	NA	NA	NA	NA	NA	NA	NA	NA
Heptachlor	< 0.45	NA	NA	NA	130	520	110	380	14	14
Heptachlor epoxide	< 0.45	NA	NA	NA	NA	NA	53	190	15	15
Methoxychlor	< 0.47	NA	NA	NA	340,000	3,800,000	31	310	19,000	19,000
Toxaphene	< 11.2	NA	NA	NA	460	1,800	440	1,600	0.42	0.42

**Table D-2. Results of Georgia-Pacific Sediment Leachate (m-WET) Analyses
(Weston, 2010)**

Analyte	GP-COMP Results (ug/L)	STLC Limit (ug/L)	Soluble Designated Levels (ug/L)	
			Low ^b	High ^c
Aluminum	14	NA	200	2,000
Antimony	2.0	15,000	6	600
Arsenic	1.14	5,000	0.004	0.04
Barium	64.4	100,000	1,000	10,000
Beryllium	< 0.04	750	1	10
Cadmium	0.520	1,000	0.07	0.7
Chloride	70,000	NA	106,000	1,060,000
Chromium	0.70	5,000	50	500
Chromium (VI)	< 2.0	5,600,000**	21	210
Cobalt	< 0.10	80,000	50	500
Copper	< 9.00	25,000	1,700	17,000
Iron	19.9	NA	300	3,000
Lead	< 0.07	5,000	20	200
Manganese	< 9.0	NA	50	500
Mercury	< 0.30	200	1.2	12
Molybdenum	11.7	350,000	10	100
Nickel	4.35	20,000	12	120
Selenium	0.250	1,000	20	200
Silver	< 0.30	5,000	35	350
Sulfate	1,550,000	NA	250,000	2,500,000
Thallium	< 0.02	7,000	0.1	1
Vanadium	< 2.0	24,000	50	500
Zinc	< 40.0	250,000	20,000	200,000

NA Not Available.

< Indicates concentrations are less than the corresponding method detection limit (MDL)

^a Soluble Threshold Limit Concentrations (CCR 2009)

^b Soluble Designated Level = [Water Quality Limit] x [Attenuation Factor] / [Dilution Factor of 10]
(CVRWQCB 2007).

^c Where natural background concentration in groundwater exceed a Water Quality Limit, Soluble Designated Level should be recalculated with Water Quality Limit set equal to background concentration (CVRWQCB 2007).

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APPENDIX F – Essential Fish Habitat

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Supplemental Essential Fish Habitat Information for Georgia-Pacific Antioch Wharf

The proposed Project is located within an area designated as Essential Fish Habitat (EFH) for three Fishery Management Plans (FMPs); the Coastal Pelagic Species, Pacific Groundfish, and Pacific Salmon Management Plans. Details of the location, purpose, and description of the proposed Project, along with minimization and avoidance measures, are discussed in the Biological Assessment. A table of EFH within the Action Area identified in the Biological Assessment, and the anticipated Project effect is provided below.

Essential Fish Habitat	Effect Determination
Coastal Pelagic Species	Not Likely to Destroy or Adversely Modify
Pacific Groundfish	Not Likely to Destroy or Adversely Modify
Pacific Salmon	Not Likely to Destroy or Adversely Modify

Background

The Magnuson-Stevens Act (as amended by the Sustainable Fisheries Act) requires FMPs to “describe and identify essential fish habitat..., minimize to the extent practicable adverse effects on such habitat caused by fishing, and identify other actions to encourage the conservation and enhancement of such habitat” (§303(a)(7)). The Magnuson-Stevens Act defines EFH as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” NMFS interpreted this definition in its regulations as follows: “waters” include aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; “substrate” includes sediment, hard bottom, structures underlying the waters, and associated biological communities; “necessary” means “the habitat required to support a sustainable fishery and the managed species’ contribution to a healthy ecosystem”; and “spawning, breeding, feeding, or growth to maturity” covers the full life cycle of a species (§303(a)(7)). A brief description of each FMP for the Action Area is provided below.

The Pacific Coast Groundfish FMP manages 90-plus species over a large and ecologically diverse area (PFMC 2011a). EFH for Pacific Coast Groundfish is defined as the aquatic habitat necessary to allow for groundfish production to support long-term sustainable fisheries for groundfish and a healthy ecosystem.

The Coastal Pelagic Species fishery includes four finfish Pacific sardine (*Sardinops sagax*), Pacific [chub] mackerel (*Scomber australasicus*), northern anchovy (*Engraulis mordax*), and jack mackerel (*Trachurus symmetricus*), along with invertebrates, market squid (*Loligo opalescens*) and all krill (*Euphausiacea* spp) species that occur in the U.S. West Coast exclusive economic zone (EEZ) (PFMC 2011b). EFH for Coastal Pelagic Species includes all marine and estuarine waters from the shoreline along the coasts of California, Oregon, and Washington offshore to the limits of the EEZ and above the thermocline where sea surface temperatures range between 10°C to 26°C (PFMC 2011b). The Coastal Pelagic Species FMP also includes two Ecosystem Component Species; jacksmelt (*Atherinopsis californiensis*) and Pacific herring (*Clupea pallasii*).

The Pacific salmon FMP covers two species in California; Chinook salmon (*Oncorhynchus tshawytscha*) and coho salmon (*O. kisutch*). EFH for Pacific salmon means those waters and

substrates necessary for production needed for a health ecosystem and support a sustainable fishery.

Analysis of Effects to EFH

Direct Effects

The Project will require the removal of existing creosote treated pilings and the placement of steel monopoles. The new steel monopoles will result in a permanent impact of 34.63 square feet (0.0008 acres) to shallow water habitat (BA Table 7). This impact will not result in the loss, reduction, or change in habitat features or functions for the three EFH FMPs.

The Project will result in the removal of 150 14-inch diameter creosote treated timber piles and approximately 20 cubic yards less fill than the existing Wharf. Removal of the timber piles will benefit EFH as removing these piles will reduce the amount of creosote potentially leaching into San Joaquin River and the downstream San Francisco Bay-Delta waters (Werme et al 2010). Additionally, the replacement Wharf will result in 157 square feet less over-water shadowing, and the new walkway will be made from a light transmitting material. Because of the reduction in fill, shading, and the removal of creosote treated piles, the Project will have a beneficial effect for EFH within the Action Area.

Indirect Effect

The impact of sea-level rise over the functional lifespan of the Wharf has been evaluated with the Project design, and is not anticipated to affect the Wharf. Additionally, steel components within the splash zone of the Wharf will have coatings or galvanization to protect them from corrosion. Indirect effects will not adversely affect EFH as a result of the Project.

Interrelated and Interdependent Effects

No interrelated or interdependent effects to EFH are expected as a result of the Project.

Cumulative Effects

No cumulative effects to EFH are anticipated to occur.

Conclusion

The Project will result in the removal of creosote treated piles and a reduction in both fill and shading, which is anticipated to result in improved aquatic habitat conditions within the Action Area. There will be no adverse change in habitat type or function for EFH within the Action Area as a result of the Project. Furthermore, the Action is not likely to destroy or adversely modify EFH in the Action Area.